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SAE: Society of A gineers, Dept. HS monwealth Drive, Pa. 15096. Order by report number.

TRB: Transportati Board, National Sciences, 2101 Cor N.W., Washington,

ABSTRACT CITATIONS

NHTSA accession number ---------- HS-013 124

Title of document ---------- **MAXIMUM BRAKE PEDAL FORCES PRODUCED BY MALE AND FEMALE DRIVERS**

Abstract ---------- The object of this research was to obtain data concerning the maximum amount of brake pedal force that automobile drivers were able to sustain over a period of ten seconds. Subjects were told to apply the brakes in the test car as they would in a panic stop, and to exert as much force as possible on the pedal over the entire ten second test period. A total of 84 subjects were tested, including 42 males and 42 females. The results indicated that there is a wide distribution of values which characterizes the pedal force that the subjects were able to generate. Male subjects produced generally higher forces than did females. Over half the women tested were unable to exert more than 150 lbs. of force with either foot alone, but when both feet were applied to the pedal, force levels rose significantly.

Personal author(s) ---------- by C. R. VonBuseck
Corporate author (or author's affiliation) ---------- General Motors Corp.
Publication date; pagination ---------- 1973? ; 18p
Supplementary note ---------- Excerpts from Maximum Parking Brake Forces Applied by Male and Female Drivers (EM-23) BY R. L. Bierley, 1965, are included.
Availability ---------- Availability: Corporate author

NHTSA accession number ---------- HS-013 165

Title of document ---------- **FRICTION MATERIALS, THEIR CHARACTERISTICS AND METHODS OF USE IN BRAKES AND CLUTCHES**

Abstract ---------- Properties of woven cotton, woven asbestos, sintered methods, and cerments are given. Reasons for wear and brake fade are described. Different types of brakes and clutches are summarized.

Author statement ---------- by Anonymous
Journal citation ---------- Publ: Engineering Materials and Design
Publication date ---------- 1973
Availability ---------- Availability: Engineering Materials and Design v17 n4 p13-7 (Apr 1973)

vironmental impact, and economic aspects with respect to the consumer, the automotive industry, and the nation in toto. They considered three principal areas of potential payoff in automotive economy: structure, including downsized cars and those resulting from far-reaching material and design changes; engine, including a top '75 engine, as well as diesel, turbine, Stirling, and electric powerplants; and drivetrain. While maintaining current emission and safety levels and performance consistent with a 0-60 mph acceleration time of 15 seconds, in modeling the total fleet, they assumed a continued trend of the current model mix: 50% six-passenger, 25% five-passenger, and 25% four-passenger. With these assumptions, the group formulated a range of vehicle concepts, from a current fleet with fuel economy of 17.1 mpg to a fleet composed of diesel-powered vehicles with upgraded drivetrain, innovative structure, and fuel economy of 33.6 mpg. It was concluded that reduced weight, technologically available powerplants, and advanced transmissions could generate a national new-car fleet by the late 1980's with 80-100% improvement in fuel economy over the 1975 baseline. There would continue to be an emissions/economy tradeoff, but continued technological improvements could offset penalties of increased cost and fuel consumption. Better performance would come at a cost of severely restricted fleet mix: six-passenger cars would have to be less than 15% of the fleet to meet a 27.5 mpg average. There would be risks in the marketplace during the transition period, both to the manufacturer and the consumer. Possible changes in purchasing habits and power could result in low sales. Investment would be required for new technology with an uncertain payoff. The task force noted crucial issues requiring resolution to meet national goals, among which are the following. How can buyer acceptance of economical cars be enhanced? What means will best minimize the investment risks implicit in the transition? How can the transition be made rapidly without undue burden on the automotive industry? How best can the Federal government provide incentives for automobile manufacturers in effecting this transition? Reader opinions are solicited.

Publ: Automotive Engineering v84 n12 p44-7, 72 (Dec 1976) 1976
Based on "The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980, Vol. 1, Executive Summary." Copies of the document and Vol. 2, "Task Force Report," are available from Paul F. Long, TAD 443, Dept. of Transportation, 400 Seventh St., S.W., Washington, D.C. 20590.
Availability: See publication

HS-020 038

TRUCK NOISE 11. EVALUATION AND REDUCTION OF HEAVY-DUTY TRUCK NOISE. FINAL REPORT

A program is described whose purpose was to test and retrofit two common truck configurations manufactured by PACCAR, Inc. to reduce their noise levels. Both trucks were cab-over-engine models, one was a Kenworth K-123 with a Cummins ble. A Sound Source Definition (SSD) test series was concluded on each truck to determine the contributed sound levels of each major system of the truck. Finally, a set of components was specified to make up a modified vehicle package which was tested and evaluated for noise abatement effectiveness. For both trucks, the only modifications specified were fan and fan speed ratio changes; all other systems were left as produced by the factories. The exterior sound level was reduced from a maximum of 91.0 dB(A) to 86.5 dB(A) on the Kenworth and from 89.0 dB(A) to 84.5 dB(A) on the Peterbilt. Interior noise was reduced from 92.0 dB(A) to 89.0 dB(A) on the Kenworth and from 95.0 dB(A) to 88.5 dB(A) on the Peterbilt. Both of these maximum interior and exterior levels were recorded in 1366 acceleration tests. The SSD testing established the cooling fan as the predominant sound source on both trucks. In descending order, the remaining systems were the engine, exhaust, transmission, intake, and chassis. A fast fourier transform analyzer coupled to a computer central processor and peripheral equipment programmed to process acoustical data digitally with 20 Hz resolution in a 1/12 octave-band format was used to analyze the sound information for spectral content. Overall results of the testing are shown in table form. Photographs of the test site and test instrumentation are provided. Twelve recommendations are made, chiefly, that the parameters controlling cooling performance and noise levels in truck environments should be thoroughly studied and documented with the following aims in mind: maintaining the cooling ability with decreased airflow requirements; decrease the fan tip-to-shroud clearance; decrease the restrictions to airflow behind the fan/radiator combination; determine the optimum shroud configurations for airflow with acoustical reductions; and develop improved design techniques to increase cooling and reduce sound levels. Appendices contain field service bulletins of Peterbilt and Kenworth, spectral analyses of sound measurements, and a description of the sound analysis equipment employed.

by V. Alan Werner; William Boyce
PACCAR Inc., Truck R and D Center, 790 Garden Ave. North, Renton, Wash. 98055
Contract DOT-TSC-708
Rept. No. DOT-TSC-OST-76-21; 1976; 188p
Rept. for Dec 1973-May 1975.
Availability: NTIS

HS-020 039

LUG-TREAD TIRES: MORE NOISE, LESS TRACTION

A study was conducted which compared the noise and traction properties of two types of treads commonly used on heavy duty truck tires. The rib tread or "highway" tread has grooves running along the circumference of the tire. The other, the lug tread or "off road" tread has large grooves running across the contact surface of the tire. The treads were tested on bias ply truck tires, and results showed that the lug tread tires were noisier on the highway, and that they offered significantly less

traction than the rib tread tires. Truck operators commonly use lug tread tires on the rear drive axles of heavy trucks. Comparative tests of various rigs and surfaces have not yet been performed to test whether this tread provides better traction than the rib tread on soft surfaces as is presumed. Some comparative traction data on three rib tread and three lug tread truck tires have been gathered through testing. All of the tires tested were size 10.00 x 20/F with a rated load of 5,430 lbs at a cold inflation pressure of 85 psi. Noise tests of the tires were conducted using SAE J57 procedures. The results of the noise level measurements are presented in table form. Averaging the figures for the two types of treads showed that at 50 mph, the lug tread tires averaged 6.7 db higher than the rib tread tires, and at 35 mph, 4.2 db higher. Traction measurements were obtained from three tests which measured cornering stiffness properties, emergency braking traction, and emergency steering maneuvers at highway speeds. All of the mobile tests were conducted on a cement concrete track. The results of Flat-Bed tests of the six tires showed that the three rib tread tires produced an average of 20% higher cornering stiffness than the three lug tread tires. The results of mobile tests of the braking traction of the tires on a dry surface showed that the three lug tread tires had a peak traction capability that averaged 13% lower than the rib tread tires at a speed of 20 mph and 9-10% lower at 40-55 mph. Mobile tests of lateral traction on dry surfaces showed that the lug tread tires performed as well as rib tread tires. Rib tread tires were shown to provide significantly more "straight ahead braking" traction than lug tread tires. Over a range of 20 to 55 mph, the rib tread tires demonstrated higher peak and slide traction than the lug treads. Mobile tests of the lateral traction properties of the six tires on wetted pavement showed that the rib tread and lug tread tires performed equally. Implications of this differential in tire traction properties are discussed. Most significant is the danger involved when a truck is operated with rib tread tires on the front axle and lug tread tires on its rear axle.

Publ: HSRI Research p1-6 (Sep-Oct 1976)
1976; 1ref
Availability: See publication

HS-020 040

DRUGS, DRIVERS, AND HIGHWAY SAFETY

A study of the existing research literature on drugs and driving includes evaluations of epidemiological and experimental studies, existing methods of measuring drug presence and its effects on behavior, legal constraints on drug/driving research, and priorities for future research. It was found that six major problems confront researchers concerned with establishing the effects of drug use on automotive safety. First, there is no common definition of the term "drug" and no adequate information concerning the extent to which various drugs are used in the general or driving population. Measuring drug effects is a problem because the concentration within the blood or urine may or may not correlate well with the concentration at the site of action in the body. The potential confusion of drug presence and drug effects is a third problem. The familiarity with the simple relationships between alcohol presence and effect has led to misunderstanding and misinterpretation of study results involving other drugs. Methods for accurately detecting and quantifying amounts of drugs in body fluids are still in a state of infancy. The difficulty of establishing the extent to which certain doses of drugs and combinations of drugs impair driving performance is a fifth problem. The many legal and ethical constraints applicable to this area is the sixth problem facing researchers. No general researcher-subject privilege exists in the U.S. and so researchers seeking to obtain information must warn the driver, the research subject, that the researcher may be compelled to disclose the driver's responses, thereby making it unlikely that reliable information can be obtained. Most of the research on the effects of single or multiple drugs on human behavior have been experimental acute dosage studies. Some of the fallacies of the experiments reported in the literature are outlined: failure to use controls to minimize subject variance, participant and observer bias; use of subjects who are atypical of the driving population; and errors in statistical analyses. The basic objective of epidemiological studies in this area has been to identify the role that drugs play in traffic crash causation. Less than 30 such studies have been reported in the last decade and most have been too limited in scope to be generalized as representative of the general driving or accident populations. Incomplete reporting methods, data and analytic techniques, and misinterpretation of data reported by researchers are problems of epidemiological studies. These studies do report the use of drugs by the driving population and their presence in accident involved drivers, and the frequent involvement of alcohol and drugs in traffic crash victims and drivers. Epidemiological literature, as a whole, strongly supports the premise that drugs do play a significant role in traffic crash causation. Future research efforts of the National Highway Traffic Safety Administration should include studies that examine drug usage patterns of the driving population, studies that examine accident populations and the driving population for concentrations of specific drugs believed to be involved in crash causation or which are widely used and have potential for behavioral impairment, and studies that examine the nature and extent of existing countermeasure efforts focused on drugs and driving.

by Kent B. Joscelyn; Roger P. Maickel
Publ: HSRI Research p7-16 (Sep-Oct 1976)
1976
The study described in this abstract was conducted under contract DOT-HS-4-00994 between NHTSA and Indiana University. The full study is reported in three volumes: Drugs and Driving: A Research Review; Drugs and Driving: A Selected Bibliography; and A Report of an International Symposium on Drugs and Driving.
Availability: See publication

HS-020 041

BICYCLE ACCIDENTS AND USAGE AMONG YOUNG ADULTS: A PRELIMINARY STUDY0 FINAL REPORT

Data on a nonrepresentative sample of 1,232 young adults aged 16 to 30 were collected in Oct. 1972, from 27 college campuses representing all nine U.S. census areas. Information was gathered using a questionnaire which consisted of over 100 items divided into sections concerning the bicyclist, the bicycle used, the person's use of the bicycle on their most recent driving day, accidents occurring in the past five years, with emphasis on those in the past 12 months, and local bicycling conditions. Given the preliminary nature of the project and the nonrepresentativeness of the sample, an exhaustive analysis of the data was not attempted. Simple frequency distributions of variables were compiled and make up the basic data of the study. Sex of driver and type of bicycle used were selected for intense study because of their importance in previous bicycle safety research. The data for accident (A) and no accident (NA) group bicycle driving experience were also compared. The bicycling of these young

type for males was greater than that for females, but females had greater estimated mileage for one speed and three speed bicycles than males. Accident rates per 1,000 miles were higher for females than for males. Males were much more likely to drive higher speed bicycles than females, and males seemed to use the three types of bicycles (one speed, three speed, 5-10-15 speed) in different ways, while females used all of them similarly. This sex difference in usage may explain why male accident/mileage rates differed among bicycle types and female rates did not. There were some differences distinguishing accident (A) group from NA group bicycle drivers. Most importantly, the A group did more bicycling, reporting both more months driving per year and more miles per month. The accident group did not, however, spend significantly more time driving per month, leading to the supposition that this group had a higher average speed. Adults were found to have more higher geared bicycles than elementary school aged children. While adult bicycle driving was evenly divided between transportation and recreation, approximately 3/4 of the children's driving was for recreation. It was found that collisions made up 67% of adult accidents but only about half of the children's accidents. In general, the difference in accident patterns between the young adults and children reflected differences in their respective exposure patterns. Appendices provide a copy of the questionnaire employed and responses to the survey questionnaire by the study group.

by Stuart A. Schupack; Gerald J. Driessen
National Safety Council, 444 North Michigan Ave., Chicago, Ill. 60611
Rept. No. NSC-051-7; PB-256 563; 1976; 74p
Availability: NTIS

HS-020 042

ON THE MECHANICAL BEHAVIOR OF THE ORTHOTROPIC CORD-RUBBER COMPOSITE

The effective elastic properties of the cord-rubber composite are deduced from the principle of virtual work. Such a composite must be compliant in the noncord directions and therefore undergo large deformations. The material model chosen met the following requirements. A stress-strain material law applicable to the case of large deformations exists for normal stresses in terms of the properties of the cord and the rubber. The effective elastic moduli of the cord embedded in the rubber were determined under both tensile and compressive loads. Finally, a relation exists that describes the elastic characteristics of the composites on the basis of effective Poisson's ratios and Young's moduli in terms of the properties of the cord and rubber. Cord-rubber specimens were prepared with 1- or 2-ply cord fabric embedded at various angles. The experiments were carried out on a Zwick-type (German) tensile test machine with the specimens held by wavy-surfaced clamps. The tensile diagrams of the rubber, cord, and cord-rubber composites were obtained. Testing of the rubber alone serves to determine the material constants. Before testing, white circles were drawn on the cord-rubber specimens to be

Poisson's ratio and Young's modulus of the composite and as a basis for their measurement in uniaxial tension.

by Odon Posfalvi
Publ: Tire Science and Technology v4 n4 p219-32 (Nov 1976)
1976; 20refs
Availability: See publication

HS-020 043

ON VISCOELASTICITY AND STANDING WAVES IN TIRES

Based on the classical ring on foundation model for the tire, the effect which structural damping has on the development of the standing wave phenomenon is investigated. The model employed consists of a rotating ring on foundation where, in addition to including Coriolis effects, Kelvin-Voigt type visco elasticity is admitted in both the ring and foundation. The main emphasis of the work is to ascertain the qualitative effects of viscoelasticity. Enforcing strict periodicity in space and time, the exact solution is obtained to the stated problem. Several parametric numerical experiments employing this solution are reported. These demonstrate that the standing wave phenomenon in tires is essentially a viscoelastic type resonance response. A conclusion is made from the investigation that any simulation of the rolling tire must incorporate the effects of viscoelasticity in the mathematical model employed.

by Joseph Padovan
Publ: Tire Science and Technology v4 n4 p233-46 (Nov 1976)
1976; 13refs
Availability: See publication

HS-020 044

A NOTE ON REPEATABILITY OF A FIFTH WHEEL

An experiment was performed to determine the length of a tread wear course and the repeatability of two fifth wheels used to make the measurement. The test consisted of two convoys of four cars each and covered 800 miles per day in two driving periods of approximately 9 hours each. The experiments with the fifth wheels were limited to a 400-mile run during the daylight hours. Two fifth wheels mounted on two vehicles in the same convoy were compared. The wheels were calibrated twice daily. It was found that the position of the fifth wheel in the convoy of four vehicles does not contribute significantly at the 95% level of confidence, nor does the difference in wheels. The course measured 397.749 miles (640.115 km) with a standard deviation of 0.115 miles (0.185 km). An average of two measurements made on such a course will produce an estimate of the course length with 95% confidence limits of magnitude less than 0.2 mile (0.3 km).

by Harry Williams
Publ: Tire Science and Technology v4 n4 p247-51 (Nov 1976)
1976
Availability: See publication

HS-020 045

A NOTE ON THE VOLUME CHANGE OF TIRES DURING WARM-UP

It has been found that increasing the temperature at warm-up produces a decrease in tire volume, contrary to expectation. A rubber specimen was subjected to constant shear stress of 35.6 psi at 35° C. After about 16 hours, when viscoelastic creep had practically stopped, the specimen, still under the same stress, was exposed to a relatively rapid temperature cycle. Strain readings taken showed the specimen to expand when cooled and shrink by the same amount when heated. For the various compounds tested, the strain changes per degree varied if the same stress level was applied. For different stress levels, it changed in direct proportion to the stress. The initial decrease is attributed to the predominance of the Gough-Joule effect over thermal expansion; and the delayed increase, to creep. After two hours of running time, a reversal of the volume shrinkage occurred. Eventually, after approximately 16 hours of running time, nearly stable conditions should be reached.

by D. J. Schuring
Publ: Tire Science and Technology v4 n4 p252-5 (Nov 1976)
1976; 4refs
Availability: See publication

HS-020 046

A NOTE ON THE CLASSICAL NET ANALYSIS OF THE INFLATED TIRE PROFILE

The classical model for the inflated profile of bias tires has been found to apply only to profiles that are convex in the sense that a straight line may intersect the profile at no more than two points. It is shown that the radius of curvature is nonnegative at all points of the profile. Concavity is possible only if assumptions of the model fail to apply. Bending resistance is a possible explanation, along with cord extension and slippage. Otherwise, the equations of the classical model involve complex quantities.

by D. W. Nicholson
Publ: Tire Science and Technology v4 n4 p256-9 (Nov 1976)
1976; 3refs
Availability: See publication

HS-020 047

EFFECTIVE CITIZEN PARTICIPATION IN TRANSPORTATION PLANNING. VOL. 1. COMMUNITY INVOLVEMENT PROCESSES. FINAL REPORT

A summary of the two-volume work reviews public participation in the transportation planning process, classifies participation techniques by function, indicates which techniques have been found most effective at each specific step in the process, and gives case studies illustrating use of techniques at the systems, corridor, and project levels. Development of citizen participation programs in recent decades has brought about the so-called Sunshine Laws. The five laws and eight administrative regulations concerning citizen participation in environmental impacts of highways, hearings on highway and transit plans, impacts of airport development, urban transportation planning, impacts of highway projects, and development of environmental action plans are tabulated. To be successful, a planning process should be open in purpose, content, and time schedule, with openmindness as a key descriptor. The structure of the process should be flexible and the public should become involved at an early stage. Transportation planning has changed in that it is now a dynamic, changing, and responsive process rather than a fixed plan of action by professional planners. Environmental impacts are now being considered. The emphasis has changed from long-term to shorter-term forecasting, and from regional to subarea (neighborhoods, counties) scope. The Federal Highway Program Manual requires an Action Plan for monitoring performance and environmental impact. Substantial design must take place at the location stage to allow for credible impact analyses and full community participation. The nineteen steps in transportation planning are reviewed. First come an inventory of trends and conditions, development of issues and policies, and forecast of population, employment and travel demand. Next follows a statement of transportation needs and objectives, alternative plans and programs, preliminary evaluation of alternatives, and identification of regional and subarea priorities. A program package is selected. Level of action decisions are followed by an annual action program, refining of location and design alternatives, and detailed environmental and feasibility analyses. An environmental impact statement is prepared then the decision is made to build the facility. Final design and cost estimates are prepared, the project is constructed, operated and evaluated. Techniques are discussed for information dissemination and collection, initiative planning, reactive planning, decisionmaking and participation process support. (Techniques are described in Vol. 2.) A graphic display is made of the relationship between the various planning stages and the various participation techniques. The key step in the planning process for citizen participation is that of making alternative plans and programs. At this stage, public opinion is most easily perceived. Case studies are presented for transportation planning at the regional systems level, a multimodal corridor study, project planning study, citizens' advisory committee for in-town sectional planning, mediation in flood control facility planning, policy capturing in community goals assessment, game simulation as training for participation, and media-based balloting to identify citizens' housing preferences.

by D. Jordan; S. Arnstein; J. Gray; E. Metcalf; W. Torrey; F. Mills
Arthur D. Little, Inc., 1735 Eye St., N.W., Washington, D.C. 20006
Contract DOT-FH-11-8514
Rept. No. FHWA/SES-76/09; 1976; 140p
Vol. 2 is HS-020 048.
Availability: GPO $2.50

HS-020 048

EFFECTIVE CITIZEN PARTICIPATION IN TRANSPORTATION PLANNING. VOL. 2. A CATALOG OF TECHNIQUES. FINAL REPORT

by De Soto Jordan; Sherry R. Arnstein; Justin Gray; Ellen I. Metcalf; Wayne R. Torrey; Florence W. Mills
Arthur D. Little, Inc., 1735 Eye St., N.W., Washington, D.C. 20006
Contract DOT-FH-11-8514
1976; 308p
HS-020 047 is Vol. 1. For each technique of citizen participation the following information is given: general description and strategy, positive and negative features, potential for resolution of controversies, utilization of various public planning programs, costs, and a selected bibliography. The following techniques are discussed: advocacy planning,

participatory process but does support and enhance the quality of such processes. Other techniques which are discussed include a community planning center, community technical assistance, computer-based techniques such as EMISARI, DISCUSS, PLATO, MAILBOX, IFTF, DELPHI, CONFERENCING, and MINERVA, a coordinator or coordinator-catalyst, a design-in and its variation, color mapping, drop-in centers, fishbowl planning, game simulation, either of the manual grid board type or of the computer-based gaming model type, and group dynamics. Use of a hotline or telephone-answering service, while not a participtory tool, is an inexpensive method of disseminating information. The most currently useful function of two-way coaxial cable TV as a communication device is for citizen polling. Simple polling without dialog is not considered to be a good problem-solving technique. Media based issue balloting, however, is more useful in that it can reach massive numbers of citizens. Community-sponsored meetings, open information meetings, and the decentralized planning council are other measures for public participation. The ombudsman, plural planning, policy capturing, and public hearings are also discussed, as are public information programs, the task force, value analysis and workshops. Indirect participatory techniques include delphi, focused group discussions, and surveys of citizens' attitudes and opinions.
Availability: GPO S4.10

HS-020 049

THE ROLE OF POLICE IN ROADSIDE HAZARD IDENTIFICATION AND REPORTING

A demonstration project was undertaken to examine the feasibility and utility of a program in which the police engage in identifying and reporting roadside hazards. Highway District Two in the State of Idaho was selected as the project site because 41% of fatal crashes there in 1973 involved fixed objects or overturning. The most frequently involved type of fixed object in both fatal and injury crashes was the ditch, followed by bank, guardrail, and utility pole. Hazard reporting forms and procedures were developed, and the officers in the project district were appropriately trained. Field reporting was then carried out intermittently by the officers for a nine month period. The police canvassed more than 700 miles of interstate, Federal-aid, and state highways, identifying over 4,000 probable roadside hazards, such as nonyielding supports for traffic lights, guardrails which can spear cars, and bridge railings not able to retain an impacting vehicle. Reports of the identified hazards were forwarded to the Idaho Div. of Highways for review of accuracy of reporting and assignment of corrective actions with estimated costs. An inventory of the information was then compiled with the aid of a computer. Objectives of the project were to find answers to several questions, among which were: Can police identify and report roadside hazards? If so, what are the difficulties and problems encountered? Can a police roadside hazard identification and reporting program lead to the creation of a hazard inventory by the state highway agency? If so, what are the problems and difficulties encountered? It was concluded that the police are very capable of identifying and reporting roadside hazards, and that the highway agency of a state can compile a useful specific provisions for roadside hazards should be designed. Nine appendices include: Dept. of Transportation's Highway Safety Program Standard 15; 1970 International Assoc. of Chiefs of Police (IACP) Resolution, "Roadside Hazards;" 1975 IACP Suggested Highway Safety Policy, "Hazardous Roadway and Roadside Conditions;" 1976 IACP Suggested Highway Safety Procedure, "Reporting Hazardous Conditions;" questionnaire to state police and highway patrol agencies; original and revised versions of the Idaho reporting forms for motor vehicle accidents; operating procedure for hazard identification and reporting; and summary of replies to questionnaire by Idaho State Police officers.

International Assoc. of Chiefs of Police, Police Management and Operations Division, Eleven Firstfield Rd., Gaithersburg, Md. 20760
1976; 83p 4refs
Supported by a grant from the Insurance Institute for Highway Safety. Cover title: Roadside Hazards.
Availability: Insurance Institute for Highway Safety

HS-020 050

STUDDED AND UNSTUDDED VEHICLE SPEEDS ON ICY AND DRY ROADS. DRIVER REACTION TO A SAFETY MEASURE

A study was performed whose aim was to determine if drivers use studded tires to increase safety or to increase speeds possible on slippery (icy) roads. Measurements of vehicle speed, spacing, and a count of the number of vehicles equipped with studded tires were taken during the early morning hours, in pendulum traffic conditions in the town of Uppsala, Sweden. A traffic analyzer TA-5 was used to measure the speeds, time, and distance between subject vehicles. The presence of studded tires was detected utilizing a detector specially developed for the project. Measurements were taken at two consecutive curves of a road under both dry and icy road surface conditions. Driver choice of speeds when negotiating a curve and not influenced by other vehicles was the driving behavior studied. The level of safety involved in driver's choice of speed was calculated by finding the quotient between the coefficient of friction taken advantage of and the maximum friction possible in the curve, and by finding the quotient between the actual measured speed of the vehicle and the highest speed possible for the curve. The test results showed that, although drivers of studded tire equipped cars are driving somewhat faster than drivers with unstudded tires on slippery roads, this increase in speed is not leading to lower safety margins. Drivers with studded tires are, on the average, driving with larger safety margins than those with unstudded tires. On dry road conditions, no clear differences were found. It is concluded that drivers seem to use studded tires to increase the safety of driving on icy roads. Extensive statistical data are appended.

by Kare Rumar; Ulf Berggrund; Per Jernberg; Uno Ytterbom
University of Uppsala, Dept. of Psychology, Sweden
Rept. No. UU-R-165; 1974; 53p 6refs
Availability: University of Uppsala, Dept. of Psychology, Sat Larsgatan 2, S-752 20 Uppsala, Sweden

Experimental data were obtained in dynamometer tests of the 1975 Datsun 119 cubic inch displacement, 2V engine to determine steady state fuel consumption and emissions of hydrocarbon, carbon monoxide, and oxides of nitrogen. The test results were obtained in detail sufficient to construct the performance maps which are presented for the entire speed/load operating range of the engine. The steady state engine data showed good repeatability. The vacuum spark advance modes showed increased fuel economy over nonadvanced modes in most cases. The oxides of nitrogen versus power curves for various engine speeds showed an increased oxides of nitrogen emission level for the advanced spark condition. The values for air-fuel ratio did not reflect the actual stoichiometry in the combustion chamber because additional air was injected into the exhaust stream. The objective of the work was to obtain engine performance data for estimating emissions and fuel economy in varied engine service and duty, and to provide basic engine characteristic data required as input for engineering calculations involving ground transportation. The comparative assessment of engine performance was not an objective and such assessment is avoided.

by W. F. Marshall; K. R. Stamper
Energy Res. and Devel. Administration, Bartlesville Energy Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003
Contract RA-75-10
Rept. No. BERC/OP-76/16; DOT-TSC-OST-76-42; 1976; 43p
Availability: NTIS

HS-020 052

ROAD RESEARCH. ADVERSE WEATHER, REDUCED VISIBILITY AND ROAD SAFETY. DRIVING IN REDUCED VISIBILITY CONDITIONS DUE TO ADVERSE WEATHER

Research on the problems of driving in conditions of reduced visibility is reported. Sources of reduced visibility include fog, rain, snow, dust, and smoke. Each source is treated independently in the statement and analysis of the problem and the physical aspects. Human factors aspects and remedial measures are treated as a whole. Fog formation is briefly described and the three types of fog - warm, supercooled, and cold or ice fog are defined. A fog density scale for classifying and identifying fog as a road traffic hazard has been developed in Italy using stopping distance as its primary parameter. A questionnaire was issued to Organization for Economic Co-operation and Development (OED) member countries in an attempt to obtain fog related accident statistics. Data received indicate that, in fog, speed is somewhat reduced, as visibility decreases. A brief definition of rain is provided, the problem of light scattering which rain causes is discussed. The three types of problems encountered in driving in the rain are considered: vehicle factors, such as window obscuration; roadway factors, such as carriageway reflectivity; and driver factors, such as vision and visibility. The accident data obtained by the group indicate that rain has the greatest effect on road accident occurrence, due primarily to reduction in visibility. Visibility reduction factors are discussed for speeds and more careful driving when snow is on the roadway. Industrial pollution and refuse burning are the two principal sources of smoke which may affect driver visibility. Dust and sand as sources are also mentioned. The human factors important to driving in reduced visibility and essential to any successful application of countermeasures are presented. Two general categories of human factor problems are emphasized - visual and psychological phenomena. A review of remedial measures is presented. A listing of adverse weather control techniques includes fog dissipation, fog dispersal by chemical seeding or mechanical sweeping, alteration of the drop size distribution, mixing dry air with foggy air, fog fences, snow fences, tree plantings, fixed lighting, legal controls on pollutants, pavement design and drainage, and vehicle improvements. Driver behavior modification through radio advisories, speed advisories, speed restrictions, convoys, road closures and detours, and driver education is discussed as well as the functional requirements of remedial measures. Methodological aspects of the evaluation of countermeasures is presented. Methods for determining the risk factor of a weather hazard include the statistical approach and analysis of driver behavior. Countermeasure effectiveness assessment is illustrated in table form. Detailed recommendations are given for the problem areas of fog, rain, snow, smoke and dust. Appendices provide a definition of fog formation and extensive statistical data.

Organisation for Economic Co-operation and Devel., Res. Group on Driving in Reduced Visibility Conditions
Rept. No. ISBN-92-64-11553-6; 1976; 98p 39refs
Also published in French.
Availability: Organisation for Economic Co-operation and Development, Publications Center, Suite 1207, 1750 Pennsylvania Ave., N.W., Washington, D.C. 20006 $5.00; Director of Information, Organisation for Economic Co-operation and Development, 2, rue Andre-Pascal, 75775 Paris, Cedex 16, France $5.00

HS-020 053

ROAD RESEARCH. POLARIZED LIGHT FOR VEHICLE HEADLAMPS. PROPOSAL FOR ITS PUBLIC EVALUATION; THE TECHNICAL AND BEHAVIOURAL PROBLEMS INVOLVED

Details of a possible large scale public trial of polarized headlights for motor vehicles are presented with a state-of-the-art review of the technical aspects and behavioral problems involved. Before any public trial can begin, overall public acceptance of the procedure must be gained and the benefits of the new device must be evaluated. The proposed trials would be conducted under controlled conditions, but in such a manner as to make few changes in normal driving practices. Data to be obtained from the study will record how the participants react, operate their vehicles, and whether or not they like the polarization system. Some objective measurements should be taken, e.g. accident frequency, causation and severity, and traffic movement. Among the tasks necessary for an international experiment of polarization are the selection of a suitable site, development of information for orientation of local authorities and road users, acquisition and analysis of ex-

test site, maintaining and monitoring use of the system during the test period, evaluating performance and acceptability, and eliminating deficiencies before the test can be initiated. The test may be administered by an ad hoc test team or a country test team on site, or an international scientific committee. National support, in the form of technical authorization, and local administrative support must be gained after a test site has been established. It will be necessary to study the laws of the specific site concerned to ensure legality of the system installed. Experimental costs must be estimated. Factors to consider are labor rates in various countries where potential sites exist, cost of equipment, operation, and maintenance. A list of favorable potential sites is provided, and cost estimates for eight sites have been projected as guidelines. The characteristics of the eight areas are shown in map and table form. It is concluded that the state-of-the-art of polarizing devices and polarizing materials and the technical criteria for their application to vehicle headlights is sufficiently advanced to assure satisfactory designs of such systems. Appendices include a review of the technological aspects of polarization, a discussion of the behavioral problems associated with a transition to polarized vehicle lighting, a list of members of the ad hoc Committee on the Application of Polarized Headlights, and a list of publications of the Road Research Program.

Organisation for Economic Co-operation and Devel., Res. Group on Lighting, Visibility and Accidents
Rept. No. ISBN-92-64-11476-9; 1976; 101p 10refs
Also published in French.
Availability: Organisation for Economic Co-operation and Development, Publications Center, Suite 1207, 1750 Pennsylvania Ave., N.W., Washington, D.C. $6.00; Director of Information, Organisation for Economic Co-operation and Development, 2, rue Andre-Pascal, 75775 Paris, Cedex 16, France $6.00

HS-020 054

ROAD RESEARCH. HAZARDOUS ROAD LOCATIONS: IDENTIFICATION AND COUNTER MEASURES

Hazardous road locations are defined as locations of highest risk (including blackspots, blacksites, and black areas); locations of intermediate risk; and locations where common situations or characteristics feature predominantly in accidents. Various techniques are available for identification, diagnosis, and classification of these locations, some well-established, some still in the process of development. Specific assessments are as follows. First, statistical and numerical techniques for main road rural networks statistical techniques are well developed for identification purposes. For urban areas numerical methods are most commonly used. Techniques are less well developed, but some useful model studies for practical application are in progress in a number of countries, especially Ireland, France, and the U.K. Second, on-site observations should include, in addition to examination of the road environment, driver behavior aspects so that engineering remedies that help to counter human failings may more readily be the quantity to be measured before it should be extended to other areas. Identification of a road hazard will involve the use of all these techniques in varying combinations. Remedial measures includ., the altering, improvement or use of the following items: geometric design, road surfacing, road markings and delineation systems, road signs and furniture, and traffic management. The assessment of which remedial measure to use requires estimates of the effectiveness of the measure in terms of the value of avoided death, injury, and damage, as well as the frequently used cost-benefit analysis. Guidelines for identifying, diagnosing and treating hazardous road locations are given as an aid to technicians and engineers; and future general and specific research needs are determined. In general, there is need for establishing optimum criteria for classification of levels and types of risk at hazardous road locations, and classifying more precisely conditions under which different countermeasures are applicable in terms of type of location and type of accident. Specifically, there are needs for more detailed investigations of events leading up to accidents as well as the occurrence of other traffic incident measures in conflict studies. Road markings must be studied in detail, then tested and compared with the aim of slowing down the driver. Certain roadside furniture such as public lighting should be studied in more detail. Better traffic management would include more research to clarify effect and possible problems of measures to reduce speed below 50 km/h.

Organisation for Economic Co-operation and Devel., Res. Group on Hazardous Road Locations: Identification and Countermeasures
Rept. No. ISBN-92-64-11570-6; 1976; 119p 145refs
Also published in French.
Availability: Organisation for Economic Co-operation and Development, Publications Center, Suite 1207, 1750 Pennsylvania Ave., N.W., Washington, D.C. $6.00; Director of Information, Organisation for Economic Co-operation and Development, 2, rue Andre-Pascal, 75775 Paris, Cedex 16, France $6.00

HS-020 055

THE POINT DEMERIT SYSTEM AS A MEANS OF IMPROVING DRIVER BEHAVIOUR

An alternative to the punitive approach to dealing with traffic offenders is presented. In the point demerit system, drivers' operating records are evaluated by assigning different values and demerits to various traffic violations committed within a given time period. Appropriate action designed to improve driving behavior is initiated upon accumulation of a specified number of points. This system is in widespread use, especially in the U.S. In general, all point demerit systems may be classified into one of two types, either statutory or discretionary. The differences between the two types are discussed, and the basic system is described. Attention is devoted to the advantages and disadvantages of the system, alternative methods for system operation, and results obtained in countries where point systems are used. A statutory point system comes into being through legislation and may be specified or authorized.

personnel who administer it and that it requires too much time to deal with problem drivers efficiently. Basically, the point demerit system seeks to provide a means to identify repeat traffic violators in order to initiate corrective action against them. A flow chart is provided which illustrates the functioning of a basic point system. Advisory letters are sent to drivers who are beginning to accumulate points but have not yet reached the suspension level. Personal interviews are conducted between a driver improvement analyst and a driver with a view toward evaluating the driver's problems. Group driver improvement meetings are held in which drivers who have accumulated a certain number of points are brought together to discuss their driving problems. Suspension or revocation follows accumulation of the specified number of points. Any kind of point system must be implemented by law and it is essential that there be a Central Licensing Bureau in order that information concerning drivers be made available to analysts. It is concluded that the point system is a good system for identifying the habitual offender but action to be taken should not be based merely on the total number of points, accured, but also on individual drivers' psychological needs. Summaries of systems operating in the U.S., Canada, Europe, Australia, New Zealand, and Japan are provided in an appendix.

by L. Oosthuizen
National Inst. for Road Res. (Nasionale Padnavorsingsinstituut), South Africa
Rept. No. IP-RU/8/75; 1975; 119p
Sponsored by National Road Safety Council.
Availability: National Inst. for Transport and Road Res., P.O. Box 395, Pretoria, 0001 South Africa Telex: 3-630 SA, Telegrams Navorspad

HS-020 056

AN ASSESSMENT OF THE PEDAL CYCLE ACCIDENT PROBLEM IN SOUTH AFRICA

Although bicycle usage, accidents, and casualties in South Africa have decreased in the last decade, the fatality rate (per cycle in use) in both South Africa and Rhodesia is about 20 times that in the U.S. Fatalities involve mostly Black and Colored adult males in rural areas, under conditions of poor visibility (dusk and darkness). Both casualties and fatalities in rural areas of Transvaal rise sharply between 4 p.m. and 11 p.m., peaking at about 7 p.m. Most serious accidents involve impact by a motor vehicle onto the rear or right hand side of the cycle. Because the accidents do not tend to cluster at specific locations, accident location improvement would not be a cost-effective countermeasure. Rather, modifying cyclist and driver behavior and improving cycle and cyclist conspicuity are more likely countermeasures. Extensive statistical data are appended.

by W. H. J. Sator
National Inst. for Road Res. (Nasionale Padnavorsingsinstituut), South Africa
Rept. No. IR-RV/2/75; 1975; 39p 13refs
Availability: National Inst. For Transport and Road Res., P.O. Box 395, Pretoria, 0001 South Africa Telex: 3-630 SA Telegrams Navorspad

determine whether the currently popular high-rise bicycle is hazardous. The accident statistics do not indicate any particular hazard; the design studies suggest that decreased stability may be offset by increased maneuverability. Therefore no restrictions are recommended for use of high-rise bicycles in South Africa. South African statistical data presented include bicycle production (1960-1974), high-rise versus all bicycle casualties, bicycle casualties among whites (both, 1963-1973) and bicycle casualties among whites by age (1973).

by W. H. J. Sator
National Inst. for Road Res. (Nasionale Padnavorsingsinstituut), South Africa
Rept. No. IR-RV/1/75; 1975; 7p 12refs
Availability: National Inst. for Transport and Road Res., P.O. Box 395, Pretoria, 0001 South Africa Telex: 3-630 SA Telegrams Navorspad

HS-020 058

CRASH CUSHIONS: REVIEW OF VEHICLE-IMPACT ATTENUATION SYSTEMS

Vehicle impact attenuation systems, or crash cushions, are made in a variety of ways. Steel drum modular crash cushions are empty drums that absorb impact by progressive crushing. The Hi-Dri cell crash cushion for restricted space and low speeds transfers vehicle momentum to water-filled nylon cells from which water is forced out through orifices. The Hi-Dri cell crash cushion (both a medium-speed unit and a cell sandwich for high speeds) utilizes vermiculite concrete helicells which absorb energy by controlled crushing. A variation is the lightweight cellular concrete crash cushion in which the vermiculite is cast around hollow cardboard drums. The Fitch internal barrier is an array of frangible plastic barrels containing varying amounts of sand; they shatter on impact, transferring energy to the sand. Crash cushions can be installed at obstacles such as bridge piers and abutments, bridge parapets and railing ends in elevated gore areas, openings between twin bridges on divided highways, heavy overhead sign supports, and stormwater drainage structures. They are designed to limit the average permissible vehicle deceleration rate to 12 times the value of deceleration due to gravity (12 G) during impacts at speeds of up to 96 km/h by vehicles with a mass range of 900 kg to 2,040 kg. The two major design criteria are the equation of energy absorption and transfer (conservation) of momentum and the criteria and performance of evaluating experimental test results. The evaluation standards used by the U.S. Federal Hwy. Administration are tabulated, including minimum permissible stopping distances. Other design conditions include ramping, somersaulting, ploughing under, optimum geometric condition, pocket, spinout or rollover, angled vehicle-impact near nose, angled vehicle-impact near rear, and redirection of angled side impacts. These problems are presented in figure form with explanations of how the resultant stopping forces may be too great on impact with the crash cushion. Tabulated data for the space requirements of crash cushion installations are presented for restricted conditions, unrestricted conditions, and preferred dimensions or upper limits of reasonable cost. Layouts of gore areas should

type of upkeep required, recreational expenditures, costs of manufacture, initial installation, refurbishment, and routine maintenance. Appearance requirements vary with location: bright for gore areas, inconspicuous for median or roadside areas. Crash cushion installation is warranted when it is not feasible to remove the hazard from a 9 m wide clear recovery area along each side of the road or when the fixed-object cannot be provided with a breakaway type of construction. Traffic speed is a warranting factor: an average traffic speed of 80 km/h or higher would be expected to result in impact speeds (after violent braking) of 40 km/h which is the speed above which fatal or serious injuries could be expected. Traffic volume is also a consideration. Other factors include past accident experience, elevated gores, twin bridges on divided highways, fixed objects, temporary protection for construction equipment, and protection for maintenance personnel.

by A. J. Jobson
National Inst. for Road Res. (Nasionale Padnavorsingsinstituut), South Africa
Rept. No. IR-RF/5/75; 1975; 87p
Availability: National Inst. for Transport and Road Res., P.O. Box 395, Pretoria, 0001 South Africa Telex: 3-630 SA Telegrams Navorspad

HS-020 059

SETTING OF MAXIMUM SPEED LIMITS

A method is described for setting speed limits in South Africa that is based on that of Great Britain and that recommended by Northwest Univ. The lowest limit for the most critical conditions is the goal. The method requires determination of the length of the given road section, consideration of circumstantial factors and their recommended speed limits followed by selection of the lowest (or next lowest) of those figures, and finally checking the road section length to ensure limits do not change too frequently. Circumstantial factors include pedestrians and bicyclists, parking and loading maneuvers, access to bounding properties, intersections, 85th percentile speed of traffic, roadway width and median strip, stopping sight distance, clear shoulder or roadside area, and accident rates. A tabular schedule of recommended speed limits in km/h is given for a variety of situations within each circumstantial factor. Also tabulated are minimum lengths of road to which given speed limits shall apply. An appendix provides a method for determining the 85th percentile of traffic speed which is considered to be a good guide to the appropriate speed for the particular road.

National Inst. for Road Res. (Nasionale Padnavorsingsinstituut), South Africa
Rept. No. IR-RF/4A/75; 1975; 25p 5refs
Availability: National Inst. for Transport and Road Res., P.O. Box 395, Pretoria, 0001 South Africa Telex: 3-630 SA Telegrams Navorspad

ment is important because it represents the intensity of loading. High contact pressures may result in four types of pavement failure which are outlined. High contact pressure is a more important factor in the fatigue failure of surface layers than wheel load, and a formula is presented for determining their combined effect. The fatigue failure of cement stabilized bases may be brought on by an increase in contact pressure from 600 to 800 kPa. A graph is presented which shows the relationship between the maximum horizontal tensile strain in the cement stabilized base and contact pressure for various three layer systems. Another form of surfacing failure is consolidation failure of thick bituminous surfacings. Tests have shown that for various surface mixes, under similar conditions, contact pressures of 280 and 620 kPa will cause average permanent deformations of about 3% and 4% respectively. Consolidation failure due to densification of lower layers is the final type of pavement failure resultant from high contact pressure. Graphs show the correlation between vertical compressive strain and contact pressure and that between contact pressure and number of repetitions of a rolling wheel load to failure. It is concluded that moderate increases in tire inflation pressure should not have a marked effect on the performance of pavements, but indiscriminate increases should be discouraged.

by D. J. Van Vuuren
Publ: The Civil Engineer in South Africa v16 n8 p267-72 (Aug 1974)
1974; 15refs
Also published as RR-192, National Inst. for Road Res. of the CSIR, Pretoria, South Africa.
Availability: See publication

HS-020 061

STUDIES OF HEAT GENERATION IN POLYESTER CORD TIRES

The behavior of the fibrous component of elastomeric composites was studied with the object of analyzing the process of heat generation in rotating tires, and in particular, estimating the temperature rise in the region of the cords. A further object was to determine whether degradation of polyester cord also causes changes in the rate of heat generation. Hysteresis losses were determined, and a significant finding was the strong dependence of loss factor on strain amplitude. Imperfect design or fabrication of a tire was found likely to generate local high temperatures in zones of high strain amplitude. When temperature profiles in model tires were calculated approximately and extrapolated for truck tires, it was found that the shoulder cord reached a temperature where degradation occurred rapidly. Aminolysis testing was performed to determine whether the polyester cord degradation that occurs in a tire under the action of sulfenamide accelerators at operating temperatures increases heat generation as well as reduces tensile strength and adhesion to rubber. Accordingly, loss factor measurements were made on samples of polyester cord treated for various times in a 0.1 M solution of morpholine in decalin. It was found that loss factors due to aminolysis increase as a result of the degradation and cause significant increases in

. E. R. Lamb; H.-D. Weigmann; B. C. Goswami
Rubber Chemistry and Technology v49 n5 p1145-59
-Dec 1976)
13refs
lability: See publication

20 062

**LUATION OF DRIVING-WHILE-INTOXICATED
OGRAMS; SOME METHODOLOGICAL
SSIDERATIONS**

udy was performed to determine the short-term and long-
effectiveness of the Akron-Barberton (Ohio) driving-
-intoxicated (DWI) program in modifying attitudes toward
. The study compared initial short-term changes in the
versus postcourse attitudes toward drinking and driving of
xperimental group of DWI enrollees with those of a con-
group of prospective enrollees who had not yet attended
es. A follow-up was conducted 1.5 years later. Assess-
is difficult for the following reasons. Attrition is high in
w-up research, thereby making it difficult to select an
uate control group. Sample sizes are very small. Deficien-
in city and state record keeping often complicate matters
derably. Furthermore, there are differences in regional
ntercity laws and in the interpretation and enforcement of
laws. It is difficult to separate the problem drinker from
driver who only occasionally drinks to excess. DWI
arch is ex-post-facto in nature, and the problems that
t from this make accurate prediction of future driving
vior from attitude scales difficult if not impossible.

ert Hayslip, Jr.; David Kapusinski; Alex Darbes; Robert

Journal of Studies on Alcohol v37 n11 p1742-6 (Nov
)
10refs
lability: See publication

20 063

**APPLICATION OF DECOMPOSITION TO
NSPORTATION NETWORK ANALYSIS.
ERIM REPORT**

e basic decomposition methods from mathematical
niques applied to transportation planning problems are
-directed, resource-directed, and dynamic programming.
l demand traffic assignment requires given interzonal trip
nds to be distributed to alternate routes between the
s with no consideration of changes in travel costs. The
mmended mathematical method is to solve subproblems
ach source using a spanning tree or shortest path al-
m (Frank-Wolfe approach). Another possibility is the use
generalized benders decomposition (Florian-Nguyen
od). Elastic demand traffic assignment differs from fixed
nd in that the origin-destination demands do respond to
es in travel costs. The dimensions of network are ex-
d to obtain an equivalent fixed demand traffic assign-
problem, to be solved as described. Both types of traffic
ment solutions can be used in mass transit planning, in-

straint. Investments may be used to expand the capacity of existing links or to introduce new links. The Lagrange multipler technique can be used to handle budget constraint. For each link, a subproblem is solved to construct the objective function for the master problem which is then solved by a traffic assignment algorithm. Generalized reports decomposition can be used to further decompose the method by geographic regions. For optimal staging of investments over time, the optimal sequence or staging of network investment decisions is determined over a planning horizon to minimize user travel costs subject to a budget constraint for each stage of the horizon. The final network configuration at the end of the horizon may or may not be specified. The method of solution is use of dynamic programming to decompose the problem into a series of network design problems. Further decomposition can be done by geographic regions using generalized Bender's decomposition. The solutions of both this problem and that of network design can be used in intercity highway planning and improvement of new construction, rail line rehabilitation, and analysis of loan guarantee and subsidy processes. Other uses include multimodal competition and interactions: analysis of legislation, investments, and incentives: and planning for transportation for energy commodities. For subarea focusing, a subarea is extracted from a very large network so that detailed changes to this subarea can be examined. Traffic is assigned within this subarea by approximating how demand external to the subarea will change in response to changes in the subarea network. Generalized Bender's decomposition is used to decompose the traffic assignment problem into separate geographic areas, and the focusing problem requires repeated solution of the Bender's master and the subarea's problem. Potential applications include single-mode planning and analysis such as decomposition of nation by region or state; decomposition by operating rail company; and analysis of intercompany competition. Multimode planning and analysis applications include decomposition by modes or by authorities; and analysis of multimode composition. Subarea focusing can also be used in mass transit planning.

by G. B. Dantzig; S. F. Maier; Z. F. Lansdowne
Control Analysis Corp., Palo Alto, Calif. 94304
Contract DOT-TSC-1059
Rept. No. DOT-TSC-OST-76-26; 1976; 126p
Rept. for Jul 1975-Jan 1976.
Availability: NTIS

HS-020 064

**NOT AVAILABLE IN CALIFORNIA 0EMISSION
CONTROLS0**

An emission control program that concentrates solely on increasing the stringency of emission control standards for manufacturers and fails to enforce adequate maintenance of in-use vehicles cannot be effective. Much evidence exists which indicates that the in-use vehicle is not being maintained and is not operating at either emissions or performance levels designed into the vehicle by manufacturers. Fuel economy, especially in California, is already penalized with the addition of automotive emission control devices, and lax maintenance compounds the loss. Manufacturers progress in reducing emis-

conservation since improved vehicle maintenance often results in greater fuel economy. Phoenix, Arizona is reported to have obtained a 10% fuel economy savings for its municipally operated vehicles from such a mandatory inspection program coupled with a regular maintenance program.

by Eric P. Grant
Rept. No. SAE-760582; 1976; 17p 23refs
Presented at West Coast Meeting of the Society of Automotive Engineers, Jack Tar, San Francisco, 9-12 Aug 1976.
Availability: SAE

HS-020 065

THE STATIC DIRECTIONAL STABILITY AND CONTROL OF THE AUTOMOBILE

A new method concerned with the development of automobile statics is based on determinations of the forces and moments that can be developed by the vehicle in the quasistatic condition without the restriction of it being fully trimmed. In this sense it follows the techniques used in aircraft and ship design for the evaluation of stability and control capability. This static/moment type of analysis has a number of advantages. First, it offers a means for defining the maneuvering boundary or maneuvering potential associated with a vehicle configuration and operating conditions. Second, it enables control, stability, and trim effects to be separated, graphically represented, and quantified over the operating range. Breakway behavior can, for the first time, be numerically assessed. Third, because it deals with forces and moments directly, it makes for compatibility between chassis and wind tunnel aerodynamic data. The compliance "add-ons" can also be conveniently expressed in force/moment terms. Finally, and perhaps most importantly, it has been found that working with the graphical presentations associated with this technique and with the fundamental relations that exist between the overall forces and moments on the vehicle, leads one to think in terms of an overall maneuvering performance portrait. This concept could lead to a comprehensive but concise means for specifying vehicle behavior. The method can be applied to the determination of control parameters of the more traditional form, but it also permits the extension of these to provide insight into behavior over the complete operating envelope. A 2df model of the automobile is used in which the only physical parameters that determine steady-state performance (and static stability) locate the center of gravity on the wheelbase, the weight, and the front and rear cornering stiffnesses. But in a real automobile other factors strongly influence static stability and vehicle dynamic performance: self-aligning torques, wheel camber effects, geometric roll steer, steer effects arising from steering and suspension compliances, lateral load transfer, and aerodynamic effects. Add-on factors are treated one at a time, thus ignoring all interactions and focusing on each factor individually -- allowing relatively easy comparisons of the influences of different factors. In the long run, the value of this new approach is thought to lie in the performance portrait and the ability to interpret capability diagrams at various operating conditions. This portrait forms a natural link between configuration -- if tires are changed, stability, control, trim, maximum lateral effects show up on the diagrams.

by William F. Milliken, Jr.; Fred Dell'Amico; Roy S. Rice
Milliken Res. Associates, Inc.; Calspan Corp.
Rept. No. SAE-760712; 1976; 131p 18refs
Presented at the Automobile Engineering Meeting, Dearborn, 18-22 Oct 1976.
Availability: SAE

HS-020 066

COMPARISON OF LOW TEMPERATURE TESTING TECHNIQUES FOR ELASTOMER SPECIFICATIONS

Specifications for low-temperature requirements for vulcanized rubber are commonly accomplished by establishing minimum values using the line call-out procedures of SAE J200 - ASTM D 2000. Resistance to impact at a low temperature is determined on specimens die cut from test slabs and tested per ASTM D 2137. Due to a considerable variation in results, the Committee on Automotive Rubber Specifications decided to investigate the precision of D 2137 and, concurrently, alternate procedures that could be included in SAE J200 - ASTM D 2000. Low-temperature tests for elastomers include the following: lowest temperature of nonfailure, including the crystallization of the elastomer; the Gehman Stiffness Test, which measures the degree of twisting under low temperatures; the temperature-retraction procedure in which the specimen is elongated, then submerged into a liquid whose temperature is low enough to freeze the specimen, and the length of the specimen recorded at various intervals as the temperature is raised. Other tests include the glass transition temperature test; forced vibration testing for dynamic properties; and the low-temperature compression set. It was decided to test further the Gehman Stiffness Test, the Temperature-Retraction Test D 1329, and the glass transition temperature and to compare these to the presently specified Brittle Temperature Test. Within-laboratory tests permitted determination of test repeatibility; between-laboratory results led to determinations of test reproducibility. Both types are necessary for determining precision of the test method. Seven laboratories participated in the brittle temperature round-robin test, six in the temperature retraction, and five in the Gehman tests. It was found that all the test methods studied leave much to be desired with regard to precision and use in specifications. In the brittle temperature and glass transition temperature tests, thermal analysis procedures are not yet sufficiently standardized for use in product specification work. In the temperature refraction test, greater precision is possible compared to the Gehman Stiffness Test because of less sample manipulation. Therefore the Temperature Refraction Test is preferred.

by William J. Snoddon
Yale Rubber Mfg. Co.
Rept. No. SAE-760221; 1976; 10p 6refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 067

PATTERN RECOGNITION AS A QUALITY CONTROL TOOL WITH APPLICATIONS TO RUBBER AND PLASTICS

The use of pattern-recognition principles is recommended as an approach to quality assurance in those numerous cases in which quality resides not in a single attribute but in a complex relationship among a number of variables. A key element in the approach is the identification of critical parameters, or features, that determine quality. Once isolated, these features can then be combined into quality indices of "signatures" capable of differentiating between acceptable or unacceptable product, even in cases in which the individual features seem to bear little relation to quality. Pattern recognition is thus seen as an adjunct to advanced testing techniques, which are effective only to the extent that the information derived therefrom can be related to the factors that determine quality. Algorithms for implementing a pattern-recognition approach to quality are discussed and are shown to be nonprohibitive in either complexity or cost. How surface geometry features affect the performance of an elastomer as a seal is cited as an example of the benefits that can be realized from the pattern-recognition approach. It is shown that, in general, surface geometry must be characterized in terms appropriate to the function to be served by the surface, and this fact necessitates a multiple-parameter description of the surface rather than the classical single-parameter description in such terms as arithmetic average (AA) or root-mean-square (RMS) roughness. The most cogent factor in evaluating the effectiveness of the methodology is clearly the ability of a particular algorithm to classify a product as acceptable or unacceptable prior to its release to the marketplace. The performance of lip seals is used as an example to illustrate this method.

by C. F. Holmes; H. T. McAdams
Calspan Corp.
Rept. No. SAE-760223; 1976; 11p 15refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 068

IZOD IMPACT - DOES IT REALLY MEAN IMPACT?

Notched Izod Impact has been accepted for purposes of data sheet values and material specifications for many years. However, these reported values can lead to erroneous conclusions regarding the real impact of plastic materials due to the morphological and visco-elastic differences between polymers. This is evident in variations in notch radius, specimen thickness, and machining techniques. Relative ranking of plastic materials using notched Izod Impact bears no relation to the ranking of the same materials tested by a drop weight method or by a no-notch Izod test. The test for measuring impact resistance for plastic materials depends on the stiffness or flexibility of the material. Of the various tests for measuring impact resistance, a no-notch test can readily be used for filled, rigid reinforced materials; a drop weight impact test would be ideal for standard grades of materials with moderate stiffness, which would not break in a no-notch test; and there is no recommended test for flexible high impact materials as these materials fail via a ductile tearing, a mode of failure completely different from the other two kinds of plastics.

by R. J. Welgos; E. C. Caughey
Allied Chemical Corp.
Rept. No. SAE-760224; 1976; 12p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 069

A SPARK IGNITION, LEAN-HOMOGENEOUS COMBUSTION, ENGINE EMISSION CONTROL SYSTEM FOR A SMALL VEHICLE

Theoretically, the combustion of homogeneous, lean air-mixtures offers potentially low emissions with low fuel consumption. An experimental investigation of a lean-combustion engine system, equipped with a lean thermal reactor, was conducted with a 1130-kg (2500-lb) vehicle. The effects of spark timing on vehicle emissions, fuel consumption, and lean reactor performance were determined. The system relied on lean combustion and a lean thermal reactor for emission control, and did not require exhaust gas recirculation (EGR), an air pump, or a catalytic converter. Emission tests conducted using the 1975 Federal Test Procedure (FTP) driving schedule showed the following results. At the minimum fuel consumption point of 0.116 l/km (20.2 mi/gal) emission levels of 0.4 g/mi hydrocarbons (HC), 3.0 g/mi carbon monoxide (CO), and 1.5 g/mi oxides of nitrogen (NOx) were achieved. Although six crank degrees of spark retard decreased HC and CO emissions to 0.25 g/mi and 2.7 g/mi, respectively, the fuel consumption was increased to 0.13 l/km (18.1 mi/gal). NOx emissions, however, were not changed. The vehicle emission levels were very sensitive to spark timing changes and carburetor calibration repeatability. Thus, implementation of such a vehicle would require careful control of these engine variables.

by Donald J. Pozniak
General Motors Corp., Res. Labs.
Rept. No. SAE-760225; 1976; 12p 4refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 070

EMISSION CONTROL WITH LEAN MIXTURES

Oxides of nitrogen emissions can be controlled through engine operation with lean homogeneous air/fuel mixtures. This emission control approach precludes the need for exhaust gas recirculation (EGR) and secondary air injection systems. The Lean Mixture concept results in similar emissions, fuel economy, and driveability when compared to EGR systems tailored to similar emission levels with similar aftertreatment systems. The Lean Mixture approach does offer the potential for less engine emission control hardware. The minimum oxides of nitrogen level achieved experimentally at the lean driveability limit was about 1.2 grams per mile but with significantly higher hydrocarbon emissions. Lean Mixture systems are sensitive to variations in engine air/fuel ratio which produce a significant effect on their emissions and fuel economy. Due to this sensitivity, it appears that the Lean Mixture concept is limited to the current oxides of nitrogen emission standards unless technological advances in fuel/air metering occur that reduce

ratios on base emissions and fuel economy as well as in conjunction with various aftertreatment systems; oxidizing catalytic converters, and lean manifold reactors. Lean Mixture systems are not compatible with reducing catalysts. A Lean Mixture-Manifold Reactor emission control system was used to evaluate the effect of compression ratio and leaded fuel on vehicle emissions and fuel economy. With the constraint of equal hydrocarbon emission levels, the classical relationship between compression ratio and fuel economy appears to have been altered. The use of higher compression ratio did not result in improved fuel economy. In addition, the use of leaded fuels resulted in both a direct and a long term increase in hydrocarbon emissions. System durability is shown for a Lean Mixture-Catalytic Converter system with lead-free fuel and for a Lean Mixture system without aftertreatment with leaded fuel. An engine dynamometer program demonstrated the incentive for improved mixture distribution. Extensive statistical data are presented.

by John F. Schweikert; James J. Gumbleton
General Motors Corp., Advance Product Engineering Staff
Rept. No. SAE-760226; 1976; 18p 3refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 071

UPGRADING AUTOMOTIVE GAS TURBINE TECHNOLOGY. AN EXPERIMENTAL EVALUATION OF IMPROVEMENT CONCEPTS

The regenerative, free power turbine gas turbine engine is a viable candidate as an alternate power plant for automotive application. The Chrysler Corp. Sixth Generation Gas Turbine serves both as a baseline reference and as a test bed for development of improvements. Baseline vehicles are intermediate-size 4-door sedans modified to accept the baseline gas turbine engine. The free rotor concept (driving engine auxiliaries from the power turbine) appears to be a more practical and lower-cost automotive power plant arrangement than the geared rotor configuration (driving engine auxiliaries from the compressor turbine). Engine performance, braking and starting are acceptable for automotive application. Low-speed fuel consumption - principally at idle - is excessive. Exhaust emissions can be controlled in the combustion process with no penalty to fuel economy or driveability. The 1975 statutory emission regulations were met. The 1978 standards appear possible using a variety of fuels with fixed geometry burner concepts currently being developed. Based on laboratory samples, satisfactory power plant endurance, durability, reliability, and serviceability were achieved. Low speed fuel consumption can readily be improved by reducing engine size and augmenting power to maintain vehicle performance. Water injection and variable inlet guide vanes are successful methods of power augmentation. The variable inlet guide vane (VIGV) approach needs to be optimized while water injection requires further development and corrosion/erosion protection of the compressor assembly. VIGV may be useful for reduction of idle fuel flow, rotor response and emission control. Ceramic regenerator cores have not exhibited the predicted superior low speed effectiveness comparable to the fully developed metal cores. Nickel oxide seals have performed satisfactorily with extremely low wear rates in fixture, engine, and vehicle applications; but alleged health hazards preclude their wide-

by Peter R. Angell; Thomas Golec
Chrysler Corp.
Rept. No. SAE-760280; 1976; 52p 9refs
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Availability: SAE

HS-020 072

THE APPLICATION OF CHEMICAL VAPOR DEPOSITED SILICON CARBIDE TO RADIAL TURBOMACHINERY

Radial turbines have significant advantage over axial flow machines, particularly in the small sizes because of their greater stage-work capacity at higher efficiencies. To realize this potential fully, it will be necessary to develop a ceramic radial rotor capable of withstanding the severe temperatures and stresses normally encountered in a gas turbine application. The analysis shows that even the best current material is just good enough for the simplest type turbine rotor. Thus it is important to develop a rotor material that can operate at the highest turbine temperature and speed with the lowest creep and corrosion rates. In addition, the material should be readily fabricated into the final shape with a minimum of diamond grinding. Chemical vapor deposited silicon carbide (CVD SiC) was selected for the material for several reasons. It has the weight of aluminum and the highest strength and lowest creep of any material at temperatures of 1300° C and beyond. CVD process capability has produced high strength filaments and, to a lesser degree, bulk material in accordance with fracture mechanics theories so as to maximize the structure for energy storage and elastic modulus and minimize the flaw or crack size. The tensile strength of CVD SiC filament material has been found to be 500,000 psi with occasional values reaching 1,000,000 psi. Thus the CVD SiC process has demonstrated the potential to produce complex turbine rotors of the type required by axial or radial machinery. Regarding the rotor design, the radial inflow rotor design permits significant varia-

HS-020 073

VARIABLE GEOMETRY COMPRESSORS FOR IMPROVEMENT OF GAS TURBINE PART LOAD PERFORMANCE

As the trend toward increasing power continues, the gas turbine engine offers obvious advantages over the diesel, such as a higher power to weight ratio, more favorable exhaust emissions, and ease of starting in cold weather. However, its poor part load fuel economy must be overcome before the gas turbine can make any impact. In order to obtain high thermal efficiency at part load, it is necessary to maintain a high turbine inlet temperature as power is reduced. Two of the most widely used methods of improving the part load performance of a low pressure ratio regenerative cycle are variable geometry power turbine nozzles and General Motor's Power Transfer, both of which reduce the rate at which the turbine inlet temperature falls with power reduction. Both are discussed briefly. The former is the better known, but the latter has been gaining acceptance and may have more potential than the variable geometry turbine. Both of these schemes involve modifications at the hot end of the low pressure ratio regenerative cycle and may become less attractive as turbine inlet temperatures are raised to improve performance. Modification at the cold end of the engine seems to present a reasonable alternative. The proposed variable geometry compressor cycle is designed around part load conditions, with maximum power being obtained by opening the guide vanes and increasing the rotational speed of the compressor. Although its performance is not competitive with current engines utilizing variable geometry turbines or Power Transfer, the variable geometry compressor does seem to offer increased potential as the trend towards higher turbine inlet temperatures continues.

by G. M. Shulhan; H. I. H. Saravanamuttoo
National Res. Council of Canada; Carleton Univ., Canada
Rept. No. SAE-760283; 1976; 12p 7refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 074

THE USE OF VARIABLE INLET GUIDE VANES FOR AUTOMOTIVE GAS TURBINE ENGINE AUGMENTATION AND LOAD CONTROL

Design and development work on variable inlet guide vanes (VIGV) was performed for use in the Energy Research and Development Agency (ERDA) upgraded Automotive Gas Turbine Engine. The feasibility of the concept of VIGV augmentation was carried out on ERDA baseline engine hardware in compressor rig and complete engine testing. The VIGV design is an articulated design providing a wider range of minimum-

the efficiency reduction at -30° and to achieve the required in
creases in flow and pressure ratio. Engine testing was co
ducted at 100% and 50% speeds, and instrumentation was i
stalled so that a direct comparison of engine and rig data cou
be made. Differences were found that at present are une
plained. Problem areas have been identified to be addresse
for providing successful augmentation with VIGV. It w
found necessary to bias the stator of an articulated VIGV
achieve increases in compressor flow and pressure ratio up
-27° flap angle. It was also found that the gas generator turbi
must have satisfactorily high efficiency and sufficiently lo
exit Mach Number and swirl angle in order not to significant
degrade the interstage duct diffusion during augmentatio
High recovery is needed in the interstage duct, and, therefor
care must be taken in the design of the interstage duct
achieve high values of effectiveness.

by R. C. Pampreen
Chrysler Corp.
Rept. No. SAE-760285; 1976; 16p 7refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 075

AN APPROACH TO ALTITUDE COMPENSATION O THE CARBURETOR

Various approaches have been considered to compensate th
carburetor and related systems such as the distribut
diaphragm and carburetor power enrichment system for the e
fects of atmospheric pressure. Three methods have practic
value, but are not pursued for a variety of reasons: the Ventu
ri By-Pass Method, the Auxiliary Jet Method, and the Fl
Bowl Back-Suction Method. The Carter altitude compensat
is a method chosen for the following reasons. It employs
variable air bleed approach that can successfully compensa
the carburetor for the effect of atmospheric pressure
air/fuel ratio. Its multiple-circuit concept provides the versatil
ty to compensate as many systems as required with one an
roid bellows. The unit is relatively compact and can be locate
integral with or remote from the carburetor. It does n
require extremely close dimensional tolerances and does n
affect cylinder-to-cylinder distribution.

by Richard C. Wrausmann; Robert J. Smith
ACF Industries, Inc., Carter Carburetor Div.
Rept. No. SAE-760286; 1976; 11p 3refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

Closed loop fuel-air ratio control systems are designed to operate at stoichiometric conditions because of the high three-way catalyst conversion efficiencies which occur only in a narrow band around stoichiometric. Closed loop control of fuel-air ratio is investigated using a temperature compensated zirconia sensor at other than stoichiometric conditions. If engines can be made to run at very lean equivalence ratios through greater attention to proper fuel-air mixing and vaporization, carbon monoxide, hydrocarbon, and oxides of nitrogen emissions are minimized simultaneously. Closed loop control in the lean region makes the system insensitive to parameter variations and allows the fuel-air ratio to be maintained closer to the lean limit than would be possible under conventional open loop conditions. Assuming lean combustion and using the Nernst equation for the oxygen sensor, equations are derived relating equivalence ratio to the oxygen sensor output voltage and temperature. Equations are also derived and discussed which give the sensitivity of predicted equivalence ratio to measurement errors in voltage and temperature and to variations in humidity and exhaust pressure. A simplified calculation scheme, which involves a linearization in equivalence ratio and which might be used in an onboard computer, is presented and its accuracy is discussed. The theoretical results are verified using experimental data obtained on a CFR engine and a system is described which predicts and controls fuel-air ratio closed loop in the lean region based on oxygen sensor and thermocouple output voltages.

by M. Hubbard; J. J. Bonilla; K. W. Randall; J. D. Powell
University of California at Davis; Stanford Univ.
Rept. No. SAE-760287; 1976; 15p 14refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 077

A VAPORIZED GASOLINE METERING SYSTEM FOR INTERNAL COMBUSTION ENGINES

A prototype vaporized gasoline metering system utilizes engine exhaust heat to vaporize liquid gasoline prior to being combined with inlet air. Evaluation performed using a 351W V-8 engine coupled to an absorption dynamometer substantiated expected results. First, the system exhibited minimal time-fluctuations in air-fuel ratio. Second, it eliminated the transient variations in air-fuel ratio due to load changes. Third, it provided a very uniform cylinder-to-cylinder distribution of air-fuel ratio. Furthermore, it enabled cold engine starts at air-fuel ratios close to stoichiometry using vaporized gasoline supplied from an auxiliary electric vaporizer. The first two characteristics permit very tight control of air-fuel ratio when coupled with feedback from an exhaust gas sensor. The third characteristic, in addition to the first two, will enable extended lean-limit operation that in turn will result in improvements in fuel economy and oxides of nitrogen (NOx) emissions. In order for lean-limit operation to be viable, however, a practical method of lowering the hydrocarbon (HC) levels as well as programming the air-fuel ratio as a function of engine load must be provided. The last characteristic should result in significantly lower emission levels during the warm-up period following a cold engine start. Constant volume sampling (CVS) emission levels. Lean-limit vapor system operation potentially provides appreciable improvements in fuel economy and NOx emissions, but at the expense of higher HC levels.

by D. R. Hamburg; J. E. Hyland
Ford Motor Co., Engineering and Res. Staff
Rept. No. SAE-760288; 1976; 18p 9refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 078

THEORETICAL STUDIES OF FUEL DROPLET EVAPORATION AND TRANSPORTATION IN A CARBURETOR VENTURI

Fuel droplets flowing in a carburetor venturi are analyzed by one-dimensional, steady, two-phase flow theories. Fuel evaporation and transportation are computed in terms of percent evaporation and droplet velocity, respectively. Among important parameters affecting droplet evaporation are droplet size, droplet temperature, and air temperature. Less significant parameters are air velocity, air pressure, and air-fuel ratio. A mathematical model can be used to evaluate order-of-magnitude effects of various design parameters affecting fuel evaporation and droplet transportation in the carburetor and induction system of an automotive engine.

by H. J. Yun; R. S. Lo; T. Y. Na
Ford Motor Co.; Univ. of Michigan, Dearborn
Rept. No. SAE-760289; 1976; 12p 12refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 079

FRAME STRESS CONSIDERATIONS IN MOUNTING UTILITY MAN LIFTS AND DERRICKS

Many failures, both major and minor, occur in utility derrick and aerial basket trucks and can be traced directly to the stresses imposed on the truck chassis frame. Installation recommendations vary according to manufacturer, pointing up the need for adequate standard mounting procedures. Stresses are given for five installations: single basket (36-ft height to bottom of basket, capacity of 300 lbs, any position), double basket (45-ft height to bottom of basket, capacity of 300 lbs per basket, any position, mounting centered behind cab and centered over rear axle), derrick truck (rear corner mount), derrick truck (centered over rear axle mount), and derrick truck (centered back of cab mount). Not only do frame reinforcement and mounting installation methods concern fleet managers, but also of concern is the inadequate design of a subframe that lacks the torsional rigidity needed to provide proper stability and protection of the sheet metal used in the utility body, manufactured in many sizes and configurations

by R. D. Rase; J. L. Williams
Omaha Public Power District; General Public Utilities
Rept. No. SAE-760290; 1976; 11p 2refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 080

TRUCK CHASSIS FRAME CONSIDERATIONS IN EQUIPMENT MOUNTING

The equipment installer is liable for the safety and durability of the installation and, as "Final Stage Manufacturer," is also responsible for compliance with all applicable Occupational Safety and Health Administration (OSHA) regulations and Department of Transportation (DOT) vehicle certification. Because of this obligation of the installer, guidelines should be available to aid the installation. The equipment installer must have knowledge of the type of terrain on which the vehicle will be operated and the load factor to which the vehicle will be subjected, as the strain on the chassis and mountings will be affected by these factors. He must know the frame material and be aware of the manufacturer's options. The stability of the vehicle must be understood and evaluated for attaching bolts (including clips, brackets, and fishplates), U-bolts and clamps, welding attachments, modifying frames, changing the wheelbase, tapering rear frames, reinforcing frames, and splicing siderails. Mounting practices involving derricks, winches, lift gates, and snowplows involve such a wide variety of trucks, loads, and installation problems, that it is necessary to deal with each mounting in detail, on a standard chassis.

by G. C. Carver
A. O. Smith Corp.
Rept. No. SAE-760291; 1976; 18p 4refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 081

AUTOMATION OF THE FINAL ASSEMBLY OPERATIONS ON THE THICK FILM IGNITION MODULE AT DELCO ELECTRONICS

The thick film hybrid circuit system is used in an under-the-hood application at Delco Electronics. It was chosen because it is an ideal device for providing the advantages of a normal solid state ignition system, and because of the company's ability to adjust the device functionally after assembly in order to peak it to optimum performance, in which case the system out-performs both its predecessor and the discrete device solid state ignition. The system is self-contained thereby eliminating much of the expensive wiring harness needed with either the conventional ignition or discrete component ignition. Its small size makes it easy to adjust its specific function. Former design and mechanization experience on the voltage regulator can be used in the ignition module. Total automation was chosen to manufacture the ignition because it provided for minimal labor costs, good quality control, and use of limited floor space. Product design constraints were minimal for automation, the substrate printing screens being the only thing requiring alteration in the manufacturing process used in making processes of the voltage regulator could be used interchangeably in manufacturing the ignition module. The manufacturing sequence and equipment description used in final assembly of the ignition module follows the substrate from first coating with palladium silver conductor pastes through to the final hot and cold electrical testing in an environmental chamber.

by G. M. Wagner
General Motors Corp., Delco Electronics Div.
Rept. No. SAE-760293; 1976; 7p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 082

ONE-THIRD OF A CENTURY OF ARMY INTEREST IN AUTOMOTIVE HYDRAULIC BRAKE FLUIDS

Since 1938 the U.S. Army has assumed a leading role in the research and development of automotive hydraulic brake fluids. This effort is justified because military requirements for brake fluids are more severe than usually encountered in normal civilian operation. Unique situations to which military vehicles are exposed include cross-country travel, fording streams, extreme climatic operating conditions, and unusual storage situations. The aim in brake fluid research and development is for maximum efficiency, safety, and simplified logistics. Because of the need for fluids that will perform in such a variety of environments, Army brake fluid specifications are more stringent and specific than industrial specifications.

by Charles B. Jordan
U.S. Army Aberdeen Proving Ground
Rept. No. SAE-760294; 1976; 8p 39refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 083

BRAKE TUBING CORROSION -- ITS CAUSES, EFFECTS, AND COMMERCIALLY ACCEPTABLE ELIMINATION

Criteria for selection of brake tubing include consideration of pressures for which the material and thickness of the tubing must be appropriate. Volumes of the transmitting medium for which the smallest and thinnest tube compatible with the service requirements will be used to maximize the effective pay load that the vehicle can carry or the space available for other components. The type of fitting must be considered as well, as it has an influence on the thickness and hardness of the rigid tubing chosen. Finally, the manufacturer must consider reliability and ensure that the properties and capabilities of the material chosen do not become markedly inferior with time or usage. Costs of brake tubing corrosion represent a considerable proportion of the total cost of vehicle corrosion and a major cause of accidents. Therefore, the material selected must meet all these criteria for adequate performance. Seamless 90/10 copper-nickel brake tubing offers a significant advantage over other materials because of its combination of corrosion resistance, strength, and formability at a price that is

by Geoffrey Wildsmith; Robert Ward
Yorkshire Imperial Metals, ltd. (United Kingdom)
Rept. No. SAE-760295; 1976; 19p 18refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 084

RACE CAR BRAKE DEVELOPMENT FOR NASCAR

Development of brakes for stock car racing began with use of ribbed aluminum drums with a cast iron liner for the rubbing surface. Changes made to increase brake strength also decreased brake effectiveness and increased the unsprung mass: gussets to support the rim so that it would not mushroom; closer spacing of the pucks of the lining so that the shoes would not bend at the gaps; and addition of two ribs to the shoe rim to prevent lengthways shoe deflection. The next improvement was the development of the Delta brake, a hybrid between the old Chrysler Center-Plane brake and the Duo-Servo brake. The high brake actuation factor of the Duo-Servo brake is retained, the support plate is eliminated. The improved air flow greatly increases heat removal, the weight dropped appreciably, hold-down nails were eliminated, piston stops were added, tension springs were changed to 17-7 stainless steel, and hold-down springs were made of chrome-silicone SAE-9254. The brake is also very easy to manufacture. Extensive tests were performed. Brake fluid was changed from ethyl glycol to silicone. Drivers prefer the old single piston master cylinder to special dual master cylinder assemblies of Girling aluminum, although the latter tested well. Brake hoses are made of steel braid. Tests using brake linings made of cast iron and copper resulted in copper rotors being recommended because they outperform cast iron rotors by increasing lining life, lowering pedal effort, and producing more consistent brake feel. To cool disc brakes, an air scoop was attached to the vehicle, but results of various tests and configurations of the scoop produced comparatively small reductions in brake temperature compared with a disc with no scoops. Tests on proper caliper location showed it to be in the rear quadrant for maximum cooling for the disc. Using stainless steel for the lining of disc brake shoes is recommended because of its strength at high temperatures. To contain fluid boiling inside the caliper, an insulating puck was placed between the hydraulic pistons and the shoes. Brake fluid boiling was a problem never completely eliminated. Because of the location of and the feedback provided by the transducers and thermocouples used as instrumentation, no observer was necessary.

by J. W. Douglas
Chrysler Corp.
Rept. No. SAE-760296; 1976; 12p 2refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 085

THE REAL POTENTIAL OF CONTAINERIZATION

The advantages of increased intermodal transportation utilizing containerization are outlined. Improved utilization of capital highway transport industries to commit themselves to complete intermodalism. Containerization promotes this intermodality since containerized shipments are capable of moving cargoes by the multiple modes of transportation. Carriers should seek the greatest flexibility so that whatever mode can produce the most efficient transportation will enjoy the traffic. Competition from air cargo carriers could present highway carriers with an opportunity for growth greater than was ever afforded by linking with railroads, since air freight, which will originate and terminate in far fewer airport locations than are served by rail, will require more long hauls over the road than are now needed for rail-borne traffic. The key to minimizing the expense of loading and unloading procedures for air lines and their highway links is unitization in containers.

by Warren L. Serenbetz
Interpool Ltd.
Rept. No. SAE-760297; 1976; 7p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 086

AN EXPERIMENTAL STUDY OF VEHICLE REFUELING EMISSIONS

When automobiles are refueled, hydrocarbon vapors are displaced from the vehicle tank and emitted to the atmosphere. An experimental program was carried out to measure both the mass and the volume of these emissions as a function of three variables: vehicle tank temperature, dispensed fuel temperature, and fuel volatility measured as Reid vapor pressure. Based on the experimental results, regression equations were developed which can be used to accurately predict refueling emissions under a wide range of conditions. An analysis of the experimental results shows that the vapor balance system is the simpler, less expensive of the two systems being considered for control of refueling emissions, and has the potential to meet strict standards under temperature conditions where ozone is likely to form in the atmosphere. The capital investment required to install the vacuum assist with secondary recovery, the other system considered, is about twice that required for a vapor balance system. The possibility also exists that an explosive mixture could be created with the latter system by drawing air into a mixture whose hydrocarbon concentration is above the upper explosive limit. Schematic drawings are provided of both of the systems.

by Albert M. Hochhauser; Raymond J. Campion
Exxon Res. and Engineering Co.
Rept. No. SAE-760307; 1976; 16p 9refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 087

NEW-TANK FUELING EMISSIONS

New-tank fueling emission was measured to determine the extent of the assembly-line fueling emission. It was predicted that the hydrocarbon emission rate would be very small since a new tank contains only air. The test results showed, however, that when fueled in the normal manner the new-tank

used tank except when the dispensed fuel quantity was small. The main cause for the new-tank emission rate exceeding that of the used tank was the degree and location of fuel splashing within the tank. Only by fueling in a splash-free manner was the new-tank emission rate less than that of a used or in-service tank. A secondary cause was the larger volume of gas displaced from a new tank due to the establishment of a higher internal vapor pressure. Fueling tests were conducted with the fuel tank and the fueling person within a SHED 58x70x86 in. The fuel tank vent pipe was connected to a pipe of the same diameter and length as it would have been on a car. This pipe passed through the mini SHED wall and led to a canister of activated carbon just as it would on a car. The tank fuel outlet pipe was plugged. A refrigerated cart with a supply of 65° F test fuel, a fuel pump, and a fuel meter was located just outside the mini SHED so that the fuel meter was visible to the fueling person through a window. The dispensing hose and nozzle were installed through a side wall. The 65° F fuel temperature was selected as being representative of fuel from underground storage. As a precaution against dispensing warm or weathered fuel, the fuel pump was not operated continuously but only as needed, and one-half gallon of fuel was pumped into a drain cart just prior to each test to ensure having fresh fuel in the dispensing hose.

by Jack B. King
General Motors Corp., Engineering Staff
Rept. No. SAE-760308; 1976; 8p 3refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 088

PROCEDURES FOR TESTING VAPOR RECOVERY SYSTEMS AT SERVICE STATIONS

Two tests procedures, the "Leak-Rate" and the "Baseline," are used to calculate the amount of vapor lost to the atmosphere or the collection efficiency during refueling. The leak-rate procedure uses a series of experimental measurements on each vehicle that make it possible to calculate the mass of vapor lost from each vehicle. The total amount of vapor lost from all the vehicles in the test sample can be averaged to determine if the vapor recovery system under test complies with Environmental Protection Agency (EPA) regulations. A slight modification of the procedure makes it possible to estimate the collection efficiency for the system. The baseline procedure involves the measurement of the amount of vapor evolved from a number of vehicles that are known to be leak-free. The collection efficiency is calculated by dividing the actual amount of vapor collected by the amount predicted by the baseline. The calculated amount of vapor lost is the difference between the amount predicted by the baseline and the amount actually recovered. Experimental data show that the leak-rate procedure can be used with an accuracy of a few percent, whereas the baseline procedure proved impractical because it is not possible to control or measure all of the variables all of the time. The leak-free procedure, tested on several hundred cars proved a straightforward, easy-to-use test

by E. M. Liston
Stanford Res. Inst.
Rept. No. SAE-760309; 1976; 15p 3refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 089

CERAMIC SUBSTRATE TECHNOLOGY FOR AUTOMOTIVE CATALYSTS

Two substrates are used to support catalysts that complete the burning of residual hydrocarbon and carbon monoxide exhausted from an automotive engine. The pebble substrate uses gamma alumina pebbles on which are distributed small amounts of the active catalyst. The pebbles are permeable to the exhaust stream and withstand extreme temperature changes from -40° to 2000° F, the temperatures present in an automobile. To avoid the attrition in automotive exhaust, attrition-resistent pebbles were developed. Gamma alumina further meets all the following requirements. It is inert to reducing conditions when the engine is running rich, or to oxidizing conditions when the engine is running lean. It is not destroyed by ash products from lubricating oil or traces of lead oxides. It is physically strong, so that small pieces are not regurgitated back into the engine or emitted from the tail pipe. It also has a very high surface area. Finally, the pebble substrate provides for extensive contact because of the considerable turbulence produced in the exhaust gas as it flows over the pebbles. The second successful catalyst structure is the monolithic support or substrate, also called the "honeycomb" structure. This configuration resembles layers of thin plates of ceramic material separated like corrugated cardboard and open to gas flow in one axis direction. Extrusion has proved the most successful process for making monolithic substrate. In this process, a wet mix of appropriate ceramic composition is extruded longitudinally through a die. The cross-section of the extrusion has the precise cross-sectional shape of the final monolith used in the automotive exhaust system. This process avoids the waste of other processes, in which the final shape must be cut from the manufactured shape. The size and shape of the passages are important in honeycomb substrates. A fine structure with many cells per square inch of cross-section, although difficult to make, has a higher exhaust back pressure, but provides more efficient contact with the catalyst. EX-32, developed by Corning Labs., provides these qualities: it has 236 cells per square inch and a triangular cell structure. The material weight per unit volume is less than others and the structure has good physical properties in all directions. Washing the monolith with a coating of gamma alumina gives the honeycomb the benefit of high surface area, like the pebbles. Both substrates will avoid most melt failures arising from incomplete engine combustion, if the engine is properly maintained and operated. Although both systems have proven capable of providing good emission control for long periods of use, there is some evidence that the pebble bed catalyst does a slightly better job of cleaning up the exhaust, once the catalyst bed has reached the functioning temperature. The monolithic system, however, is lighter, the amount of heat required to warm up the bed

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., Product Planning and Developmental Staff
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he Automotive Engineering Congress and
etroit, 23-27 Feb 1976.
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LASTICS PROCESS FOR CATALYST ES

eveloped for manufacturing PORAMIC (registered onolithic honeycomb for ceramic substrates for catalyst differs from others where binders are he material is treated as a filled thermoplastic, s ceramic powders with binder. Suitable ceramic nixed with a thermoplastic binder system, after which the plasticizer is removed. Removing the e key to the system, permits such a high viscosi- melting point that no distortion takes place when is heated and the binder is burned off. The he structure allows escape of the combustion he binder without distortion of the structure and nal bubble formation in the walls. The porosity e finished goods, adding to that created by the e binder and allows tailoring the final porosity to s required for proper catalyst coating. PORAMIC yond the capabilities of present ceramic products g extrusion and shaping using conventional ssing equipment.

ndsager; Gordon J. Turner; Joseph L. Pentecost nd Co.; Georgia Inst. of Tech.
E-760311; 1976; 8p 8refs
he Automotive Engineering Congress and
etroit, 23-27 Feb 1976.
AE

D DRIVING

ould be investigated relative to driving, but par- e with potential for deteriorating motor skills and this category fall nonprescriptive drugs such as ee, nicotine, and cough syrups, and prescriptive s sedatives, hypnotics, tranquilizers or ataraxics. s. Illegal drugs for investigation should include such as marihuana, peyote, DMT, LSD, d STP; and narcotics such as heroin, Codeine, d methodone, not necessarily illegal, also should ed. Other drugs for investigation should include s, antidiabetics, anticonvulsants, anticoagulants, and motion sickness preparations. There is of drugs affecting driving, and there are no accident rate available related to drug-user driv- y, drugs are combined with alcohol. Alcohol and oduce a synergistic depressant effect. When al- bined with stimulants, the stimulants do not an- neutralize the effects of the alcohol. Little is the effects of alcohol combined with hallu- arcotics. The lab findings have shown that non- drugs have no significant effect on driving when imal normal dosages. Sedatives and tranquilizers fants were added to alcohol, no improvement in motor skills developed. An attitudinal survey of marihuana users revealed they over-evaluate their driving abilities, are less prone to use other drugs, and recommend against driving by other marihuana users. LSD causes severe disorientation and a virtual inability to drive. There has been no research into hallucinogens and their effect upon driving skills. It is difficult to assess the crash risk of drug users because of the wide variety of drugs, the different quantitative and qualitative effects on users, the difference in duration of effects, the possible cumulative or interaction effects from prolonged or combined drug usage, and different individual reactions. All require considerable research. It is, furthermore, more difficult to detect mind-altering drugs than it is alcohol; LSD and marihuana are virtually undetectable. Emphasis should be placed on more adequate research concerning the drug-driving phenomenon and not on more rigorous legislation and enforcement procedures. It will be necessary to develop methods for the detection of hallucinogens in users. Further screening methods will be needed for the detection of all drugs. More sophisticated research designs must be incorporated into investigations of the drug-driving phenomenon. More rigorous laws concerning drugs and driving may not be appropriate at the present time. New procedures and countermeasures must be made on a cost-payoff basis. Because drug use does not appear to be a major factor contributing to highway crashes and fatalities, countermeasures must be designed accordingly. Finally, it is important that accurate factual information on drug use be disseminated without contamination by sensationalism, emotional over-reactions, and unwarranted assumptions or speculations.

by James L. Nichols
Matthew Bender and Co., Inc., 235 E. 45th St., New York, N.Y. 10017
1975; 63p 95refs
Reprinted from the Aug 1975 issue of TRAUMA.
Availability: Corporate author

HS-020 092

ROADSIDE SAFETY: THE STATE OF THE ART

Highway appurtenances (or "highway furniture") are the cause of death in approximately 33 to 40% of last year's fatal accidents involving collisions with roadside obstacles. New technology is being used to correct the highway hazard problem. Sign supports, both metal and wood, are being designed to break away upon impact. Luminaire design standards now call for acceptability tests to be based on impacts by lightweight vehicles of 2,250 pounds impacting at 20-60 mph, resulting in a change of momentum of 750-lb seconds or less. Only three such supports currently meet these standards: the aluminum AT50 system; the fluted aluminums, 30 and 50-ft high; and the aluminum slip base, 40 ft high. Utility poles still remain a major hazard, and consideration must be given to their removal or relocation. Curb design standards currently call for curbs of 4 inches or less to be acceptable; of 4-6 inches to be removed where experience has shown vehicle vaulting to be a serious consequence; and curbs higher than 6 inches to be removed. Drainage structures, no longer a prominent problem on interstate and primary roads, remain hazards on secondary roads. The most effective and acceptable drainage structure for median use is the contoured concrete-and-steel grille drainage inlet, although it remains a serious hazard for motorcycles. Guardrails, currently taking a

toll of 6,000 lives every year, are being changed to remedy the problem. Some new offerings are the following. The Texas Twist is being developed to prevent vehicle rollover and to provide improved redirection for impacting vehicles. The Guard Rail Energy Absorbing Terminal (G-R-E-A-T), a narrow impact attenuator, telescopes when hit head on, with Hi-Dri vermiculite concrete cells absorbing the energy. The Breakaway Cable Terminal (BCT) combines the beneficial aspects of a cable restraint with breakaway post features to eliminate impalement of the impacting vehicle by the guardrail end. Median barriers need proper construction for acceptable safety: there should be only 2-4 ft between rail and bridge pier. The SWOV barrier obtained from the Netherlands is proving very effective. Earthern berm barriers still need testing for redirecting high speed traffic before they can be considered acceptable. In crash cushion development, the Hi-Dri System, which is effective where appurtenances can not be relocated, is comprised of many 6-inch diameter, water-filled cells, that, under impact, decelerate the vehicle by controlled expulsion of the water through specially designed orifices at the top of each cell. Reusability, mass-velocity sensitivity, and ease of maintenance are key characteristics of this system. Vermiculite concrete, which is being studied as a barrier material in the Hi-Dri impact attenuator, is used in cartridges in canisters to dissipate energy as the cells are successively crushed. This system survives freezing weather, in addition to being quickly reusable and easily maintained. The Fitch Inertial Barrier is an impact attenuator used where head-on hits are anticipated as the predominant accidents. The upper portion of plastic tubs placed in free-standing array around a fixed object is filled with sand that disperses into the surrounding areas as the tubs and other frangible elements disintegrate. The Energite barrier is often used with the Fitch barrier where head-on collisions are anticipated. The Minnesota Bullnose uses a guardrail with a blunt nose; the rail becomes a tension member, pulling down posts which are sheared at the base to slow down the vehicle. Finally, the G-R-E-A-T system can be attached to the ends of guardrails or concrete median barriers to provide safe attenuation and redirection capability for vehicle impacts in either direction.

by F. J. Tumanini
Publ: Traffic Engineering v46 n2 p39-42 (Dec 1976)
1976
Availability: See publication

HS-020 093

A STUDY OF ACCIDENT RATES ON RURAL ROADS IN DEVELOPING COUNTRIES

A report is presented of research on the relationships between personal injury accident rates on rural roads in Kenya and Jamaica and factors such as vehicle flow and road geometry. An analysis of road accidents involving personal injury in Kenya showed that single vehicle accidents were particularly prevalent on rural roads, making up almost 50% of the total number of accidents occurring. It is probable then that design features of the road were a significant factor. From data obtained from various sources in Kenya and Jamaica, it proved possible, using multiple regression analysis, to relate the accident rates on rural roads in these countries to certain design characteristics of the road. In Kenya, the accident rate per million vehicle kilometers was significantly related to the number of junctions per kilometer, the horizontal curvature, the vertical curvature, and the surface irregularity. In Jamaica, it was found to be related to road width, and junctions per kilometer. It was concluded that the accident rate per kilometer, per annum was significantly related to vehicle flow while the rate per million vehicle kilometers was significantly related to the physical characteristics of the road tested. Comparisons were made with similar relationships derived in the developed countries of Russia, Sweden, Australia, Great Britain, France, Hungary, West Germany, and the United States. The accident rates in Kenya and Jamaica were found to be consistently greater for similar values of vehicle flow and geometric design. It is likely, therefore, that other factors such as road user behavior and vehicle condition and maintenance are involved. It is recommended that these factors be the subject of future research. Test data which were collected are presented in tables and graphs.

by G. D. Jacobs
Department of the Environment, Transport and Rd. Res. Lab., Overseas Unit, Crowthorne, Berkshire, England
Rept. No. TRRL-LR-732; 1976; 23p 20refs
Availability: Corporate author

HS-020 094

STUDIES OF THE ROAD MARKING CODE. FINAL REPORT

The findings of two survey studies concerned with the communication to the driver of road marking meanings are presented. Study one investigated drivers' understanding of road marking patterns, and information was obtained on the acceptance of road marking applications. A questionnaire administered to 104 persons in the Federal Hwy. Administration, Office of Res. and Devel. and 126 Coast Guard recruits at Cape May, N.J. was the source of the data. Lane marking applications most favored primarily concern those used to indicate the driver's proper path of travel under adverse conditions or when a difficult maneuver is called for. Road marking applications which received adverse driver ratings generally attempt to communicate meanings that the driver may find difficult to interpret or which he may consider unnecessary. Respondents did not show a satisfactory understanding of road markings: more than one quarter of the respondents improperly defined single solid white, single wide white, double broken yellow, single broken yellow, and single broken white markings. Subjects correctly defined meanings of the double solid yellow line and the solid-dashed yellow combination. Study two was concerned with drivers' preferences for road markings as indicated by their choices of the most "logical and understandable" markings to fit a variety of common highway situations. Subjects were 23 Baltimore firemen and 73 Coast Guard recruits tested at Cape May, N.J. Subjects' selections which coincided closely with the Manual of Uniform Traffic Control Devices (MUTCD) recommendations were: single broken white line used to separate lanes of traffic moving in the same direction; single solid white line to show the curb marking of a highway; and double solid yellow to show center markings of a highway with two lanes in each direction. It was shown that, to the respondents, a broken line means crossing is permitted, a solid line means crossing or passing is forbidden, and that yellow colored markings are associated with hazard, not with traffic direction as is the MUTCD assigned meaning. The very high percentage of respondents who did not understand the road markings implies that driver education is desirable. Study findings lead to questions concerning the advisability of using yellow markings to indicate separation of counter-moving traffic. Most subjects were unaware that yellow markings are intended to indicate opposite movement of

traffic in the adjacent lane. Other significant reasons for limiting the use of yellow markings are toxicity of yellow lead chromate, expense, and recognition difficulty as compared to white under adverse weather conditions. It was recommended that yellow markings not be used to indicate counter flow traffic, but rather where a real hazard exists, such as on railroad crossings, bus stops, left turn channelizations, dangerous curves, and highway repair areas. Respondents' explanations of road marking meanings are tabulated and presented. Appendices include questionnaires used in the studies, and a description of the research evidence which indicates that drivers expect markings to communicate the safe path of travel and to tell where passing may be safely achieved.

by Donald A. Gordon
Federal Hwy. Administration, Analysis and Experimentation Group, Washington, D.C. 20590
Contract FHWA-211.3-062
Rept. No. FHWA-RD-76-59; SR-HRS-31; 1976; 80p 3refs
Availability: NTIS

HS-020 095

HOW TO SAVE GASOLINE: PUBLIC POLICY ALTERNATIVES FOR THE AUTOMOBILE. EXECUTIVE SUMMARY

by Sorrel Wildhorn; Burke K. Burright; John H. Enns; Thomas F. Kirkwood
RAND Corp., Santa Monica, Calif. 90406
Grant NSF-GI-44
Rept. No. NSF-RA-N-74/21; R-1560/1-NSF; PB-242 756; 1974; 26p
For abstract see HS-020 099.
Availability: NTIS

HS-020 096

THE WELFARE EFFECTS OF FUEL ECONOMY POLICIES. FINAL REPORT

Justifications for discouraging the consumption of gasoline include the relationship of vehicle exhaust pollutants to health and the benefit to both national security and balance of payments if importation of foreign oil could be reduced. Stockpiling (strategic storage) and import quotas and tariffs have the same effect; choosing among them is a matter of weighing the relative costs to society. President Ford's advocacy of both a strategic storage program and a proposed tariff on imports appears to be concerned with lowering oil prices as well as with national security. A simple model of fuel economy has as its two objective functions are to reduce gasoline consumption beginning in a target year below a prescribed baseline level, and to minimize the integral over time of total gasoline consumption subject to some secondary constraints. An increase in price affects usage of all vehicles equally, gasoline demand by older models will be unchanged, older models will not drop from the vehicle stock more rapidly, and greater efficiency of new cars will cause them to be used more. The amount by which efficiency will have to be improved depends on the elasticity of demand for vehicle use. An equation is derived for the national average fuel economy which focuses simultaneously on usage, stock of cars, and individual miles per gallon (all by vintage and type of auto) modified to allow for the fact that a vehicle designed to last longer may be more economical of energy than one which has to be replaced more often, irrespective of its mpg rating. An integrated model is presented of the demand for automobiles and the demand for gasoline. Both the demand for new cars and for gasoline are derived from the demand for motor-car transportation. The demand for an equilibrium car stock is formulated as a function of the level of income and the user-cost of motor-car travel. A shortfall of actual car stocks from those desired is assumed to affect the demand for new cars through the used-car market rather than directly. The short-run demand for gasoline in the model derives from the selection of a utilization rate of the existing car stock. Both the individual consumer response and the auto industry response are gauged to the following: an excise tax on gasoline, a progressive excise tax on weight, on horsepower, on engine displacement, and on the shortfall of fuel economy from some mandated standard, and forbidding the operation of models that do not meet a certain specified fuel economy. The taxes which are most efficient for discouraging the use of low fuel economy cars are those which are imposed on fuel economy directly, e.g. an excise tax on gasoline or a progressive excise tax on the shortfall of fuel economy from a specified standard. Manufacturers would not be able to substitute away from the characteristic taxed without having the desired effect on the fuel economy. A methodology is derived for quantifying the effects of fuel economy policies. The more effective policy would apply to the entire existing car stock rather than just to new-car additions, would focus on gasoline consumption directly, and would probably take the form of an excise tax on gasoline. Its deadweight loss on society is no greater and perhaps somewhat lesser than that of any other policy. Ranking of other policies in order of decreasing merit are progressive tax on fuel economy shortfall, on curb weight, on engine displacement, on brake horsepower, forbidding the sale of models that do not obtain a specified minimum fuel economy, and rationing.

by Lester D. Taylor; Philip K. Verleger, Jr.; Catherine J. Hirtzel
University of Arizona; Data Resources, Inc., Energy Group, 29 Hartwell Ave., Lexington, Mass. 02173
Contract DAT-7407-C6.3
Rept. No. MVMA-DAT-74-09; PB-256 640; 1975; 86p 27refs
Availability: NTIS

HS-020 097

THE EFFECT OF TAX AND REGULATORY ALTERNATIVES ON CAR SALES AND GASOLINE CONSUMPTION. FINAL REPORT

Gasoline consumed by passenger vehicles is predicted for the period 1974 through 1976 with existing assumptions about technology and fuel efficiency, and incorporating assumptions about six tax and regulatory alternatives. In the baseline forecast, new car sales are estimated to rise from a depressed level of 10.3 million units in 1974 to 11.3 in 1975 and 11.7 million units in 1976, after which they will increase at an annual rate of 0.2 million units to the 13.7 million mark in 1986. Total passenger vehicle registrations will rise from 93 million in 1974 to 102 million in 1977, after which they will increase 2 million per year to 120 million in 1986. Total miles driven by passenger vehicles will decline this year to 1.01 trillion miles from the 1973 level of 1.06 trillion, but will rise to 1.11 trillion in 1977, 1.19 trillion in 1980, and 1.43 trillion miles in 1986. Average mpg for all cars will increase slowly from 13.8 in 1974 to 14.6 by 1980 and 15.1 by 1986. As a result, gasoline consumed will decline from 76.4 billion gallons last year to 72.8 billion this year, rise to 78.0 billion in 1977, 81.0 billion in

1980, and 94.6 billion in 1986. Six tax and regulatory policies given by the Council on Environmental Quality could be implemented. The cost and efficiency responses from the dual report to this study were used together with the estimated car equations and the Chase macroeconomic and industry models to determine the effect on car sales, gasoline consumption, and the overall economy. The taxes imposed were generally set equal to a $100 tax for each mpg that a car fell below the specified base, which was set at either 18 or 20 mpg. An average case is considered in which new car sales would be 0.3 million units below the baseline forecast in 1975, 1976 and 1977 and 0.2 million units less in succeeding years. Total passenger vehicle registration would be 2.2 million or 2% lower by 1986, and total miles driven would be reduced from 1.43 to 1.41 trillion, a 1.5% reduction. Because of the engineering response elicited by these taxes, average mpg would rise substantially from 15.1 to 18.0 mpg. The greatest saving of gasoline occurs for the case incorporating the assumption of the exponential tax. Average fuel efficiency is 0.9 mpg higher in 1978 and 3.7 mpg higher in 1986. The effect on the general economy is quite modest. Prices are slightly higher during the 1975-1977 period but the mild slowdown in the economy leads to slightly lower prices by 1980. At the industry level, the only significant changes occur in the automobile and auto-related industries, such as tires, batteries, metal stampings, ball bearings, and steel. Auto production is down a maximum of 13% in 1977; other declines range from 3% to 8%. As car sales return to within 0.2 million of the baseline level, the economy recovers and changes in both output and employment at the industry level are negligible by 1980 and in later years.

Chase Econometric Associates, Inc., One Chase Manhattan Plaza, New York, N.Y. 10015
Contract EQC 004
Rept. No. PB-234 622; 1974; 118p
Availability: NTIS

HS-020 098

COMPARATIVE ACCIDENT COSTS IN DEVELOPING COUNTRIES

Information from studies conducted in seven developing countries has been collated: Kenya (1965), Ivory Coast (1970), Thailand (1963 and 1964), Southern Rhodesia (1961), South Africa (1963), Israel (1967), Ghana (1970), and Turkey (1971). Data from Great Britain have been included to give a comparative order of magnitude and because the methodology employed in the British studies gives a good base for discussing the other studies. The main results produced by each study are tabulated. Table one describes the costs associated with each type of injury for each country and the average material damage costs incurred in a road accident. For each type of injury, loss in output (future income less future consumption) and medical expenses are the costs incurred. Other tables indicate the average cost of different types of road accidents as well as estimated total accident costs for the country concerned, and the percentage of total costs by major category, i.e., loss in output, medical costs, and vehicle damages. Direct comparison of the absolute values given in the tables would be misleading since, for example, in the British study, the 1963 cost of fatality was measured on the basis of a net loss in output while the 1970 figure was measured on the basis of a gross loss in output. Apart from differences in the measurement of the losses, there are also differences in actual definitions of what is being measured. Despite such great disparities in study output, valuation, and definition, some general conclusions have been drawn from the figures obtained. The average personal injury accident cost for developing countries tends to be high compared to Britain. This is probably due to the high severity indices found in developing countries and the probable under-recording of minor accidents. Material damage unit costs show a fair consistency in order of magnitude from country to country, apart from Thailand. The base data for the comparison came, in most of the countries, from police or insurance company records, but most studies employed cross checking techniques to overcome the deficiencies inherent in the use of these data sources. The method of valuing accident statistics is probably the most controversial aspect of accident analysis. The main argument concerns measuring the benefits of life. Apart from the South African study, all of the studies collated used either a gross or a net valuation of lost output as the direct cost of a fatality. The gross output method is justified on the basis of the benefit the individual expects to get out of livelihood, i.e. the material benefit that would be lost in the event of death. In general, the average wage is used as a measure of output, and shadow wage rates are frequently used to value the effort of housewives. It is concluded that the soundest arguments favor the use of a gross valuation for measuring output, and the use of aggregate data is to be preferred because they do not emphasize any category of persons.

by P. R. Fouracre; G. D. Jacobs
Department of the Environment, Transport and Rd. Res. Lab., Overseas Unit, Crowthorne, Berkshire, England
Rept. No. TRRL-SR-206-UC; 1976; 18p 20refs
Availability: Corporate author

HS-020 099

HOW TO SAVE GASOLINE: PUBLIC POLICY ALTERNATIVE FOR THE AUTOMOBILE

Analytical tools are developed to help evaluate national energy conservation policies for private transportation, and the tools are then applied in a systematic analysis and comparison of several alternative measures and policy instruments. Energy conservation measures and policy instruments are considered from two viewpoints: the improvement of auto fuel economy or modal energy efficiency from a technological and transportation management standpoint; and reduction of vehicle miles travelled, especially raising the price of driving by raising prices of gasoline and new and used cars. Improving fuel economy through technological means can be accomplished through vehicle design, including removing air conditioning, using radial tires, reducing aerodynamic drag, driving smaller cars, lowering performance by use of lower power engines, utilizing advanced materials such as glass fiber reinforced plastics and aluminum, and improving the power train by the use of a continuously variable transmission (CVT). Policy instruments included for analysis in the models used for screening and evaluating alternative measures and policy instruments include increased gasoline tax, mandated technological changes, a mandated average fuel economy standard for new cars, a mandated maximum vehicle weight standard for new cars, various combinations of the foregoing, and an average increase in new and used car sales tax or regulations fee. There is no clear dominance of one policy over others in the medium and long term. If there is a need for substantial conservation in the short run, the only hope is to impose additional gasoline taxes, despite the adverse impacts. In the longer term, regulatory policies aimed at improving new car fuel economy offer greater potential for gasoline and energy

conservation than do gasoline taxes. New auto technology holds great potential for improving fuel economy, and any subsidization of the auto industry by the Federal government should include work on advanced versions of the ICE and CVT. In regulatory policymaking, the most general mandate is probably to be preferred: mandating an average new car fuel economy standard is more general than mandating a weight standard or technology standard. A fuel economy standard much higher than the 16 to 20 mpg standard is feasible. Radial tires and minor aerodynamic redesign of all new auto bodies should be included in any new car fuel economy standard. The imposition of a fixed tax on new car sales price offers little promise for gas conservation in the near term. If national energy conservation objectives are phrased in terms of constant relative savings of gasoline or energy over time, it is possible to design reasonable combinations of gasoline tax policies and regulatory instruments to implement such objectives. Finally a desired improvement in average new car fuel economy in the longer run can be achieved with several types of policies. Of these the one that involves the lowest new car price (while maintaining the comfort and performance of today's cars) will reduce total automobile gasoline the most.

by Sorrel Wildhorn; Burke K. Burright; John H. Enns; Thomas F. Kirkwood
RAND Corp., Santa Monica, Calif. 90406
Grant NSF-GI-44
Rept. No. NSF-RA-N-74/20; R-1560-NSF; PB-242 755; 1974; 195p refs
First rept. in a series of three. HS-020 095 is the executive summary.
Availability: NTIS

HS-020 100

FUEL CONSERVATION MEASURES: THE TRANSPORTATION SECTOR. FINAL REPORT. VOL. 1

Several of the numerous measures which have been suggested to conserve transportation energy are evaluated as they relate to the State of Texas. Estimates of potential fuel savings for each measure are documented and for those instances in which data are available, an evaluation of the success of programs instituted since the energy shortage became public knowledge is presented. The most effective voluntary conservation measures are those designed to reduce urban travel. It is estimated that the elimination of unnecessary travel by urban residents could result in a fuel conservation of a maximum of 8.5% of statewide highway motor fuel. Car pooling could result in a 2.7% savings, and increased usage of urban public transit could result in an approximate 1% savings. The implementation of staggered work hours would bring about a smoother traffic flow, but would serve to make car pooling more difficult. A savings of 0.9% of statewide motor fuel consumption could result. The practice of walking and/or bicycling for trips that are short enough to be conductive to those forms of transportation could reduce fuel consumption by 1.9%. The implementation of traffic engineering improvements that would allow vehicles to operate at fuel efficient speeds and reduce unnecessary speed changes in the traffic stream could save less than 2% of statewide motor fuel. Improving the fuel efficiency of individual vehicles by convincing the public to take affirmative action in the areas of vehicle weight, auto maintenance, and driving habits could reduce fuel consumption by 5%. Fuel conservation could be practiced by business firms by reducing travel, and maximizing the operating efficiency of diesel powered trucks and buses.

by Ron Holder
Texas A and M Univ., Texas Transportation Inst., College Station, Tex.
Contract GEAC-GI44085; GEAC-SIA73-05812
Rept. No. PB-243 324; 1975; 82p
Proj. S/ID-9. Vol. 2 is HS-020 125.
Availability: NTIS

HS-020 102

FUEL CONSUMPTION, EMISSIONS, AND POWER CHARACTERISTICS OF THE 1975 FORD 140-CID 0CUBIC INCH DISPLACEMENT0 AUTOMOTIVE ENGINE--EXPERIMENTAL DATA. INTERIM REPORT

Experimental data were obtained in dynamometer tests of the 1975 Ford 140 cubic inch displacement, 2-bbl engine to determine steady state fuel consumption and emissions of hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The test results were obtained in detail sufficient to construct the performance maps which are presented for the entire speed/load operating range of the engine. Engine performance data show good repeatability. Brake horsepower, torque, and brake specific fuel consumption (bsfe) at wide open throttle (WOT) for various engine speeds show results typical of gasoline engines and are in fair agreement with manufacturer's engine specifications. The air-fuel ratio versus power trend was repeatable for each engine speed throughout the entire operating range of the engine. The air injection system promotes the oxidation of unburned hydrocarbons and carbon monoxide by introducing the air into the exhaust stream at a point where the gas temperatures will support combustion. This system maintains low CO and HC emission rates except near WOT. The NOx emissions were well controlled throughout the tests and showed peak emission rates typically near 75% of full power for any given engine speed. Fuel rates were found to be nearly linear with power up to about 75% of maximum power for any engine speed. Minimum values of bsfe can be found near this condition. The objective of the work was to obtain engine performance data for estimating emissions and fuel economy in varied engine service and duty, and to provide basic engine characteristic data required as input for engineering calculations involving ground transportation. The comparative assessment of engine performance was not an objective and such assessment is avoided.

by W. F. Marshall; K. R. Stamper
Energy Res. and Devel. Administration, Bartlesville Energy Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003
Contract RA-75-10
Rept. No. DOT-TSC-OST-76-43; BERC/OP-76/15; 1976; 41p
Rept. for Feb-Apr 1976.
Availability: NTIS

HS-020 104

HYBRID DRIVE WITH KINETIC ENERGY STORE AS VEHICLE DRIVE (HYBRIDENTRIEB MIT

KINETISCHEM ENERGIESPEICHER ALS FAHRZEUGANTRIEB)

Motor vehicles with conventional internal combustion engines consume large amounts of fuel when operated in heavy city traffic. The absence of energy regeneration during braking and the uneconomical part load consumption of the internal combustion engine are the causes. A transport vehicle fitted with an internal combustion engine and a modified, hybrid drive with a gyro component has demonstrated a 45% lower fuel consumption per unit distance for the same driving cycle as the conventional Otto engine. It was found that a high regeneration efficiency can be obtained by a direct exchange of kinetic energy between a vehicle and a gyro (flywheel) during acceleration and braking. Because of its favorable weight per unit power, a gyro can temporarily transfer the high dynamic power for starting or braking. When connected to a gyro, the internal combustion engine has to supply only the basic power. Of the many ways possible to build a drive structure from an internal combustion engine and a gyro, the need for vehicle controllability and hill climbing ability led to the design of the drive structure as described. The structure consists of the gyro with parallel connected internal combustion engine and an electric machine whose power outputs are superimposed in a differential gear unit. There is equilibrium between the torques at the inputs and at the output of the summing gear unit. Thus, the output torque can be regulated by means of the torque of the electric machine. The drive's power can be regulated by means of the torque and speed of the internal combustion engine. For a stationary vehicle and ready-to-operate drive, the drive elements rotate in opposite directions. In this state, the internal combustion engine can feed energy into the gyro or via the differential gear unit and electric machine into the batteries. During steady state driving, the powers of the internal combustion engine are combined with the positive or negative power of the electric machine in the differential gear unit. The gyro component rotates at a constant speed and thus releases no energy. The dynamic performance trials of the drive structure were run on a flat test road, and the determination of fuel consumption under cyclic driving conditions was made. The choice of test cycles corresponded to the distribution of dynamic factors in real traffic sequences. Test results showed that regeneration of braking energy accounted for 14% of the 45% fuel economy achieved, and that more efficient use of the internal combustion engine accounted for 31%. Analysis of test results and computer simulations show that a fuel consumption reduction of 50% over a broad range of traffic dynamics can be achieved while maintaining high dynamic driving performance. A list of abbreviations used in the report is appended.

by H. Schreck; F. Torres
Technical Univ., Aachen, Inst. of Automotive Engineering, Germany
Rept. No. UCRL-Trans-11018; 1976; 19p 4refs
Presented at the Second Symposium on Low-Pollution Power-System Development, Dusseldorf, Nov 1974, paper 28
(CONF-741151). Translation from German.
Availability: NTIS; UCRL Trans-11018

HS-020 105

COMPUTERIZED ENGINE TEST SYSTEMS FOR

engine design parameters are computer acquired. The config ration allows one processor and its interfaces to automatical control four independent test cells concurrently. The Centu Processing Unit (CPU), the heart of the system, is an Int data Model 7/16 computer with 64K bytes (8 bit half-word) memory. Complimenting the main frame is a Diablo Model disk unit having 5 megabyte removable and 5 megabyte fix capability. An ADDS 980 CRT terminal and keyboard are t primary operator interface and test system monitor. T results and certain CRT displays are printed on a high-spe 60-200 LPM Centronics 101 line printer, on demand. The p mary system status/program terminal is a Teletype ASR User generated test plans are entered into the system means of Hollerith cards fed into the system via a Mohar Data Science 300-card-per minute card reader. Dynamome reference speed, engine throttle position, spark advance a fuel rate are computer controlled, utilizing feedback to cl the control loops. Optimization techniques are applied via F tran algorithms to perform actuator control, achieving point repeatability.

by Robert J. Boozang; James P. Fentress
Hamilton Test Systems, Inc.
Rept. No. SAE-760941; 1976; 8p
Presented at the Off-Highway Vehicle Meeting, Milwaukee, 13-16 Sep 1976.
Availability: SAE

HS-020 106

ON-ROAD TRUCK PERFORMANCE SIGNATURE INFORMATION SYSTEM

An on-board system utilizing a general purpose microcompt has been developed to monitor, record, and display parame data relative to truck function, condition, and performa The system provides a means to identify the performa signature of an individual truck in its operational environm over the road, to record it, track it with time, and de deterioration prior to breakdown. It acquires the data while truck is on the road under actual operating conditions. Th data are processed on board the vehicle for display or se tive recording, then transferred to an off-board computer further processing. The 22 sensors selected include temp ture (brakes, coolant, engine oil, exhaust, transmission), p sure (air tank, air filter, fuel filter, oil filter, coolant, en case, engine oil, brake pedal), level (coolant, engine oil), sp (vehicle, engine), and other (battery voltage, fuel use, pe take-off, ignition, state crossing). All sensors are continuo monitored, but differing actions are taken in recording the sor outputs. The sensors are compared against pre thresholds. Truck electronics, which supply power and exc tion for the sensors, include interface electronics microprocessor, a program memory, and a storage mem The portable data transfer unit incorporates a magnetic sette recorder and is connected to the truck electronics uni a cable and a quick disconnect connector. The diagnostic play console is optional to the basic system but enhances value of the system. Continuously accessible, it can be use three ways. It can be interconnected directly to the truck tronics unit through the data transfer connector, thus pr ing access to all the truck sensors and truck data stored du the last trip. It permits a real time diagnostic analysis in w

ory of the truck condition and performance. The central computer is accessed directly or through a telephone line. System loop closure is provided through people entry to correct data or to change the program. The end product of the system is a maintenance, repair, operations or procurement action -- the correct action performed at the correct time with the minimum cost impact.

by H. O. Williams
Rockwell International
Rept. No. SAE-760834; 1976; 11p
Presented at the National Truck Meeting, Indianapolis, 2-5 Nov 1976.
Availability: SAE

HS-020 107

LET'S TRY TO DISPEL SOME HIGHWAY SAFETY MYTHS

The "nut behind the wheel" myth or the often repeated statement that 80 to 90% of all accidents are created by driver error is instrumental in causing a lack of respect for highway engineers and leads to marginal activity in highway related safety programs. The Department of Transportation, in its 1975 annual report, and the National Safety Council, in its "Accident Facts" have served to perpetuate the myth by putting the blame on the driver in most accidents reported. Police accident reports provide the source for most accident data. Because the policeman's responsibility is to determine accident liability, he approaches any accident investigation looking for violations of the law, and he can usually find one. A rationale that almost any accident was caused by the human factor is easy to establish, but human error is not the only factor. Confusing directional signs, narrow bridges, lack of sidewalks, unsignalized intersections can also be primary causative factors. The 1975 National Safety Council's "Accident Facts" states that in 30% of all fatal accidents, no improper driving was indicated. Driver error contributes to many accidents and so does the highway environment. The environment may lead the driver into error or prevent him from making the right decision. The real danger of the 80 to 90% myth is that it leads to the false assumption that engineers can shrug off responsibility for safety. The current reasoning seems to be that engineers' efforts can only impact a small percentage of accidents since most accidents are caused by the driver and this small percentage is not worth much attention. Actually, the environment has a highly significant impact on safety. Hundreds of documented studies exist which indicate that such improvements as horizontal and vertical alignment changes, stabilization of shoulders on rural two lane highways, and widening narrow bridges effect significant accident reductions. Environmental safety improvements have shown more substantial results than those of both vehicle and driver programs combined. A more forgiving environment for the pedestrian can be provided by the engineer by designing more adequate physical separation for the stalled motorist and by designing more reasonable cross walks. It is believed that a rate of 0.73 fatalities per 100 million miles is not an unreasonable rate to aspire to through better engineering. The "construction and maintenance zone" myth is related to the 80 to 90% myth. Engineers seem to have the general attitude that the safety of the driver through work sites is not of major importance. Most construction site accidents are attributed to driver error, but the Federal Hwy. Administration recently made an 18-state survey and found that, generally, construction sites in all states need improvement in the interest of safety. Construction zones are by nature hazardous areas, but the engineer can take special care and make them safe.

by H. L. Anderson
Federal Hwy. Administration, Washington, D.C.
Publ: Traffic Engineering v46 n12 p20-3 (Dec 1976)
1976; 1ref
Availability: See publication

HS-020 108

CoO SENSORS FOR MEASUREMENT AND CONTROL OF EXHAUST FROM LEAN-BURN ENGINES

An experimental exhaust sensor using cobalt oxide (CoO) ceramic is being developed for measuring and controlling air-to-fuel ratio (A/F) of internal combustion engines operating under lean-burn conditions. The operation of the sensor is based on the fact that at elevated temperatures the electrical resistance of CoO depends on the oxygen partial pressure (PO2). At controlled temperatures, the combination of good PO2 sensitivity, high reproducibility of the electrical properties, and small temperature coefficient of resistance of CoO materials make this sensor suitable for the lean A/F range (15-20) where exhaust PO2 depends only weakly on A/F ratio. At low PO2 (A/F less than 13.5) and high temperatures, CoO reduces to Co; therefore, prolonged exposure of the sensor to these conditions must be avoided. Experiments to determine long-term stability of the properties of CoO in the exhaust gas environment have shown that when several CoO specimens were kept at high temperatures in furnaces for periods of two to three months and subjected to various gas environments and temperature cycling, there was no effect on either the resistance vs PO2 relationship or the absolute value of the resistance. Sensors made with porous CoO ceramics have shown response times in the range of 0.1 - 0.5 sec, and optimization of the structure is expected to result in still shorter response times. As limited vehicle testing has been carried out, further work is needed to establish sensor behavior under engine operating conditions.

by G. L. Beaudoin; K. R. Laud; E. M. Logothetis; A. H. Metzler; K. Park
Ford Motor Co., Engineering and Res. Staff
Rept. No. SAE-760312; 1976; 8p 8refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 109

SYSTEM SAFETY: A NEW APPROACH TO TRAFFIC SAFETY

System safety is a technical/management approach to safety, developed initially by the Dept. of Defense and the National Aeronautic and Space Administration to consider the safety aspects of a total system. The current state of safety methods in traffic and in transportation, as a whole, is fragmented into such areas as accident studies; driver training; studies of reaction time or sign legibility; and safety vehicles. By bringing all of these aspects of safety together, administratively, and adding certain analytical techniques taken from the field of reliability engineering, the concept of transportation system safety is emerging. A three year study has been funded by the Dept. of Transportation to develop a methodology for system safety

which will be applicable to all modes of transportation. System safety is intended to regularize and order safety considerations from the earliest stages of concept formulation through design, testing and evaluation, construction, training, certification, operation, and maintenance. The first year phase is identification and resolution of key issues in transportation safety, and preparation of a draft methodology for the study of transportation system safety; second year, application of the methodology as developed, selection, execution, and reporting of case studies; third year, refinement of the methodology, generalization of guidelines, and further testing if necessary. System safety procedures require a logical examination of all elements of a system, identifying all possible sources of accidents, estimating the problem of their occurrence, and pointing out available options for their elimination. The TAC ring (Transportation Activity Cycle) (illustration provided) concept represents a progression from concept formulation, say of a road, to planning it from a functional standpoint, to designing it from a detailed engineering standpoint, to producing or building it, to operating it. The System Safety Program Plan (SSPP) helps management achieve the basic goals and objectives of the system. The SSPP provides for the definition of the system by its boundaries and the details of its infrastructure, setting of safety goals and objectives, and determination of organizational structure and responsibilities, identification of hazards and how they can be controlled, definition and description of scheduling and review procedures, description of methods for evaluating and monitoring performances, and definition of the data base and documentation requirements and procedures. The final SSPP is used in the engineering design stage and emphasizes technical and engineering aspects rather than the managerial considerations. Through the use of a systematic approach to safety, potential hazards can be identified before they are activated.

by E. J. Cantilli; M. Horodniceanu; L. J. Pignataro
Publ: Traffic Engineering v46 n12 p36-8 (Dec 1976)
1976; 6refs
Availability: See publication

HS-020 110

CARS OF THE 1980s

Cars of the 1980's will be smaller, lighter, safer, and more fuel efficient. By 1985, cars of that model year must achieve the standard of 27.5 mpg. The present 55-mph speed limit has proved a great safety factor and should be maintained; the traffic fatality rate per 100 million vehicle miles driven declined 3.47 in 1974, the lowest level on record. The Research Safety Vehicle program conducted at DOT is developing an automobile in which occupants could survive a 50-mph head-on collision and is fuel efficient and environmentally compatible. Fuel economy standards for the years 1981-84 which are not met will result in a penalty to the manufacturer of $5 for each one-tenth mile below the standard. Encouraging lighter-weight, more efficient cars could result in fuel savings of 1.3 million barrels of oil a day by the 1990's, compared to 1975, even though car use increases nearly 50%. The Interagency Task Force on Motor Vehicle Goals Beyond 1980, set up in Mar 1975, was formed because of the nation's dependence on cars and to provide a balanced information base for informed discussion. The findings of their report are substantial. Large industry efforts, investments, market risks, and a reasonable approach to government regulation will be required to meet the 27.5 mpg standard by 1985. Possible negative results may be lower occupant protection levels, higher exhaust emission levels, and reduced carrying and trailer-pulling capacities. Th dilemma is to convince the public of the need for fuel-efficie cars and to encourage their purchase. Public cooperation is e sential. Further findings of the task group concern weigh safety and other factors. Lighter vehicles must provide t same interior and trunk space, but will be shorter and use al minum and plastics. Safety can be achieved through outsi measures: improved guardrails, traffic control systems, i creased use of the three-point safety harness, and potent passive passenger restraint systems. Little hope will be fou for a highly efficient electric vehicle until new batte technology is developed; current deficiencies exist in th range, payloads, performance, cost, and overall energy ef ciency. Newer cleaner cars will reduce air pollution. Reduc auto emission depends as much on timing and degree of tigh emission standards as on new technological developments. F ture cars will have smaller tires, fewer spark plugs, less lub cation oil, and more modular units that can be easily replac The cost to industry is estimated by the task force to between $5 and $10 billion above the normal spending facilit and equipment. Consequently some government financial h may be necessary for the auto industry.

by William T. Coleman, Jr.
Department of Transportation
Publ: Motor Trend v29 n1 p34-6 (Jan 1977)
1977
Availability: See publication

HS-020 111

1975 AUTOMOTIVE CHARACTERISTICS DATA BASE. FINAL REPORT

A total of 216 vehicle configurations was selected to repre the 1975 new car fleet. Each vehicle is described by appr mately 50 attributes including fuel economy, emission con system and levels, acceleration performance, vehicle inte and exterior dimensions, engine characteristics, price, production quantities. A statistical section presents the im tant characteristics of the 1975 new car fleet presented in v ous tables, histograms, plots, and regression analyses. This formation is useful in econometric modeling and the de mination of automobile design characteristics. A user's in mation guide is included which provides specific details of data base, and presents operating instructions for users familar with it. The Automotive Characteristics Data (ACDB) was developed because there was a need for an cient and unified location of automotive characteristics for in conducting studies of automobile energy consumption, economy, and fleet analysis. The report emphasizes the u of efficient data retrieval methods in fuel economy anal statistical data reporting, and fleet mix analysis. The siz the data base was limited to the selection of those vehicle figurations which would be representative of the U.S. 197 tomotive fleet.

by Moses Rouse; William Basham
Department of Transportation, Transportation Systems Ce Kendall Square, Cambridge, Mass. 02142
Rept. No. DOT-TSC-OST-76-27; 1976; 137p
Rept. for Jun 1975-Jun 1976.
Availability: NTIS

HS-020 112

THE SAFETY VALUE OF DRIVER LICENCE LICENSE0 RENEWALS. AN ANALYSIS OF RESEARCH RESULTS

The driver relicensing test is intended to prevent accidents by identifying apparently unsafe drivers; secondarily, it may motivate drivers to educate themselves in traffic safety. Accident proneness or personal liability can be documented only after long observation since occasional variations in the accident pattern are large. Neither the driving test results nor the correlation between traditional knowledge of traffic regulations and signs with accident rate are satisfactory indicators of a driver's accident risk level. Thus the prospects of such prediction are not encouraging. A general exclusion of physically or mentally handicapped drivers is not warranted, since their accident rates seem to be well within the normal range. A scheme for ensuring that a driver's visual acuity and field of vision are adequate involves relatively more frequent examination of older, class II, and poor-eyesight drivers than for the general driving population. Vision is the only sensory defect considered to be limiting to driving ability. Factors which do correlate with accident proneness are age, gender, marital status, previous violations, and previous accidents. Documented experiences with driver improvement techniques are not justified for adoption in Norway, in connection with driver license renewals. In summary, there seems to be no evidence for assuming there are any safety benefits from the current (up to Jun 1975) Norwegian license renewal procedures. Since the procedures are an expense to society, alternative measures are needed, the value of which can be documented. The features of the present system which ought to be retained in revised form are medical examinations and renewal of driving licenses for identification purposes.

by Peter Christensen; Alf Glad; Trond O. Pedersen
Institute of Transport Economics, P.O. Box 26 Slemdal, Oslo 5, Norway
Rept. No. ISBN-82-7133-149-3; 1976: 48p 52refs
Proj. 1038. Sponsored by Directorate of Roads and Ministry of Communications, Norway. Originally published in Norwegian in 1974.
Availability: Corporate author

HS-020 113

THE SECRETARY'S DECISION CONCERNING MOTOR VEHICLE OCCUPANT CRASH PROTECTION

In keeping with the National Traffic and Motor Vehicle Safety Act of 1966 provisions to reduce traffic accidents along with deaths and injuries to persons resulting from such accidents, Federal Motor Vehicle Safety Standard (FMVSS) 208 followed in 1968 requiring seat belts installed in all cars. NHTSA is seeking an amendment to require passive restraints. Questions exist as to whether the public will or will not accept passive restraints because of additional cost, discontinuance of lap and shoulder belts, and little public experience with passive restraint technology. Information from interested persons was requested at a 1976 public hearing, and all material presented was reviewed. The decision is go with passive restraints, which are technologically feasible, would provide substantially increased protection to the public in traffic accidents, and can be produced economically. They will be available to consumers by 1 Sep 1978 in a demonstration program to appraise the public of and familiarize them with passive restraint benefits, possibly thereby creating a demand for them. The cost of the demonstration program will be borne by the automobile industry in substantial part. Appropriate insurance premium reductions are being requested for purchasers of these cars. Seat belt usage will be promoted concurrently with the demonstration program. With results of the demonstration program and seat belt usage promotion, a decision can be made whether to mandate passive restraints in all new cars. The demonstration program is the most responsible means of determining public acceptability of passive restraints. It is the Secretary's conclusion that the appropriate role of the Federal Government in prescribing motor vehicle safety standards involves his present decision that much of the potential for reducing deaths and injuries through occupant restraint systems can be realized only through installation of such restraints, and that such protection is owed to the public. Air bag installation increases freedom of individual choice (air bag or seat belt) and the marketplace (various kinds of airbag systems), and is equitable given the magnitude of the benefits, the ultimate cost of the system, the number of seat belt users, and the uneven size of insurance premium reductions. Benefits include reduced deaths and injuries and lower insurance rates. Costs include installation of the system itself in the vehicle, a 0.57-0.71% increase in fuel consumption from the additional system weight, and the possibility of fewer cars sold; but savings (e.g. in insurance and medical costs) would offset these costs. The demonstration program is estimated to cost approximately $15 million for the two years. None of the hazards feared by critics has been shown to constitute any significant risk. All other alternatives available to the Secretary were rejected for various reasons: continuation of the existing requirement, State mandatory safety belt usage laws, Federal field test of passive restraints, mandatory passive restraints, and mandatory passive restraint option.

Department of Transportation, Washington, D.C. 20590
1976; 85p
Availability: U.S. Dept. of Transportation

HS-020 114

SCHOOL BUS SEATING FOR PASSENGER PROTECTION AND SAFETY. A DESIGN STUDY PRESENTED BY UNITED STATES STEEL

A new school bus seat design is offered which would be efficient and, constructed of the right steel, would contribute maximum effectiveness and safety. Seatback heights for all school buses should be at least 28 inches high. Seatback strength should include allowance for passengers thrown forward against the backrest and should be sufficient to withstand, without failure, a 30-g deceleration forward, head-on, and a 20-g acceleration forward, rear-end. Seat anchorages and seat cushion fasteners should not fail from forward decelerations under 30 g's. Seats should not be provided with rigid protruding structures such as handgrips, handrails, and similar injury-producing appurtenances. Thin padding covering rigid tubular structures such as the top of the seatbacks and armrests cannot counteract the problems of an inadequate design. A high-strength, high-backed safety seat represents the most important single contribution to school bus passenger collision safety, the next important being the three-point belt. Design of the top edge of the bus seats was considered as similar to the passenger-side zone of an energy-absorbing automotive instrument panel. Seating should provide expanded seat capacities, sufficient leg room, and aisle-side hip retainers that would also support the seatback. Considerations of load

transfer connections led to the following decisions. Because of limited spacing, the seat should be noncollapsing with a diagonal leg placed in the opposite direction, permitting buckling failure under impact. Individual legs for each pair of seat belt ends should be incorporated despite the clutter resulting from three sets of legs and a wall connection. The most likely of several improved floor connections was recommended. The prototype uses steel sheet to provide an integral contoured back and seat, meeting dimensions of children from 13-17 years. Individual legs support the aisle side and each seatbelt anchor point. The other side of the seat and the last seatbelt end are anchored to the side structure of the bus. The computed tube section for the seat legs is a one-inch square tube formed from 16-gage steel sheet having a 36,000-psi minimum yield strength. The seat pan, exclusive of the energy-absorbing top rail, is also made of 16-gage mild steel. The feet of the aisle-side seat supports angle in to provide aisle walking room. The seat has an integrated impact-energy-absorbing cushion five inches in diameter and an aisle-side hip retainer with a rolled one-inch diameter. The seat is connected to the floor through supporting floor members capable of withstanding the imposed loads, and is padded front, top, and back with one-inch thick cellular vinyl rubberized hair pad and covered with vinyl. Static tests were conducted for seat displacement and direction of strain using two belted 50 percentile males, 165 lbs, each decelerating evenly at the rate of 30 g's. Static testing showed the seat capable of meeting 30-g deceleration head-on and 20-g acceleration rear-end in the forward direction. Preliminary dynamic testing results performed with the test vehicle traveling at 35 mph at impact showed the prototype withstood barrier impact successfully. The seatback panel did deform under impact, allowing pocketing of the knees for passengers behind. One modification is presented using a conventional spring seat which would require a minimum number of modifications. It has an impact-absorbing seatback, aisle-side retention device, seatbelt manifold that withstands 15,000 pounds, resisted by the supporting leg structure and the floor.

U.S. Steel
1968?; 42p 13refs
Availability: Reference copy only

HS-020 115

THE TRAJECTORIES OF PEDESTRIAN DUMMIES STRUCK BY CARS OF CONVENTIONAL AND MODIFIED FRONTAL DESIGNS

Two hundred and forty-five tests were carried out to investigate the influence of the front-end configuration of cars on the trajectories of dummy pedestrians which they hit, both for the front-ends of conventional cars and for experimental designs. Tests with conventional cars at nominal impact speeds of 8, 16, and 24 km/h showed that while the adult pedestrian folded over onto the hood before falling off, the child was knocked down. Reducing the height of the hood sufficiently to pick up the child causes the adult to strike the windshield. The simplest method of reducing pedestrian injury is to adopt a front-end which provides optimum trajectories for the adult, and to provide suitable energy-absorbing designs for the leading edge of the hood and the front face of the bumper. To pick up both child and adult dummies on the hood and retain them requires a sloped front-end and a device which positively lifts the child at low impact speeds. An experimental front-end and catcher has been developed for the purpose which performs satisfactorily at impact speeds up to 16 km/h. It has a front-end slope of 60-70° and is designed so that it could be suitabl stretched to match a hood higher than 720 mm.

by V. J. Jehu; L. C. Pearson
Transport and Road Res. Lab., Vehicle Safety Div.,
Crowthorne, Berks., England
Rept. No. TRRL-LR-718; 1976; 20p
Availability: Corporate author

HS-020 116

ALCOHOLISM AND TREATMENT

NIAAA established a Monitoring System requiring routine r ports on clients receiving treatment at 45 community cent throughout the U.S. both at intake and at 6 months after take. The alcoholics entering treatment at NIAAA centers severely impaired in behavioral and social terms from exc sive use of alcohol. However, they show substantial impro ment in drinking behavior after treatment, both at 6 mon and 18 months following intake. The rate of improvement is the order of 70%. The improved clients include only a relati ly small number who are long-term abstainers. The major are either drinking moderate amounts of alcohol--but at lev far below what could be described as alcoholic drinking--or gaging in alternating periods of drinking and abstention. At 18-month followup, roughly equal numbers fall into the cate ries of 6-month abstention, periodic drinking (abstained month only), and normal drinking. The fact that most proved clients are not abstaining for long periods of ti when considered in terms of recent research on contro drinking, prompts a definition of remission that includes b abstention and "normal" drinking. The key finding of relapse analysis is that relapse rates for normal drinkers are higher than those for longer-term abstainers, even when analysis is confined to clients who are definitely alcoholi intake. This finding suggests the possibility that for some coholics moderate drinking is not necessarily a prelude to relapse, calling into question the conception that alcoholis caused exclusively by a physiological predisposition to ad tion. In accepting normal drinking as a form of remission, study is by no means advocating that alcoholics should tempt moderate drinking after treatment. In light of the fin that untreated clients attending Alcoholics Anonymous meetings regularly also have remission rates near 70%, suggestion is strong that formal treatment may play only a cremental role in the recovery from alcoholism. The rat "natural" remission appears to be fairly substantial. It app that the fact of treatment is more important than the spe type of treatment, with the important proviso that to pro a remission rate exceeding that due to natural processes treatment must be given in sufficient amounts. Recovery alcohol dependency may depend on mechanisms quite lated to the factors that led to excessive drinking in the place. Appendixes deal with reliability and validity of se ported drinking behavior and with data collection instrume

by David J. Armor; J. Michael Polich; Harriet B. Stambul
Rand Corp., Santa Monica, Calif. 90406
Grant NIAAA-2-R01-AA-01203-03
Rept. No. R-1739-NIAAA ; 1976; 228p 302refs
Availability: Corporate author

IMPLEMENTING COMMUNITY MERGENCY MEDICAL SERVICES

erning development of emergency medical ntended for use by the citizen or local offi- nity level, with an emphasis on improving ulance services. The experience on which d is EMS planning and implementation in o Area Council of governments region sur- nio and Bexar County, Tex. EMS planning onsideration of financial resources, private ration, and shared sponsorship. A broad- committee is required to identify available ne the range of services, choose between a system, and design a training program in- first aid training. Subcommittees should ving specific areas of concern, and draw up checklists and an implementation schedule. concerns quantity of ambulance personnel , availability and training of dispatchers, , a supervisor, and community training in tation planning concerns ambulance quanti- it, and garaging, as well as consideration of nce use. It is also concerned with response procedures. Health care industry coordina- es of EMS to be provided, and physician ipation. Communications planning involves ween the EMS system, and the consumer, rew and dispatcher, and between vehicle l personnel or supervising physician. Or- nancial planning must take into considera- ordinances, statutes, licenses and certifica- al roles and delegation of responsibilities, expenses and revenues). Approval of the ht from the health care providers and local d to these are public support and coordina- and state planning agencies. Implementation ion of a manager and an implementation . Implementation involves a coordinated se- tion and training of personnel; selection and ances, medical supplies and equipment, and uipment (UHF or VHF radios); negotiation surance, intergovernmental services and mu- ment maintenance; documentation of opera- budgeting, billing, and the means of ac- forming and educating the public.

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RM-00007-05

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ION TIME OF ROTATED SYMBOLS FOR AUTOMOBILE

ols, intended to be recognized at a glance, easingly to identify automobile controls. A ent was conducted to examine certain gnition problem when the knob on which ears is rotated. Ten subjects made timed, same-different responses to three pairs of standard control symbols differing in orientation. The time required for mental rotation for all symbols was found to be a linear function of angle. There were no significant differences between symbols. The mean rate of rotation was 130°/second. Since the expected time for this added mental operation is nontrivial, the time available to survey the road ahead is reduced. Consequently, the probability of missing an accident generating hazard is increased. It is therefore suggested that the symbol standards be modified to require symbols to be displayed only in their perceptually upright positions.

by Paul Green; George Davis
Publ: Journal of Safety Research v8 n4 p180-3 (Dec 1976)
1976; 21refs
Availability: See publication

HS-020 119

THE EFFECT OF BIKE LANES ON TEN CLASSES OF BICYCLE-AUTOMOBILE ACCIDENTS IN CALIFORNIA

The bike-auto accidents in Davis, Calif., a city with a long standing bike-lane system, were classified in 10 accident categories or the Cross system of proximal cause: cyclist exited driveway into motorist path; motorist exited driveway into cyclist path; cyclist failed to stop/yield at controlled intersection; cyclist made improper left turn; cyclist rode on wrong side of street; motorist collided with rear of cyclist; motorist failed to stop/yield at controlled intersection; motorist made improper left turn; motorist made improper right turn; and motorist opened car door into cyclist's path. The relative frequency of accidents in each category in Davis was compared to that in Santa Barbara, a comparable community without bike lanes. Within Davis, streets with bike lanes were compared to those without bike lanes using the same categories. Three accident types were judged to be uninfluenced by bike lanes either the cyclist's or motorists' failure to stop or yield at a controlled intersection, and improper left turn by motorist. They were used as a standard for determining the effect of bike lanes on the absolute frequency of other classes. Relative to these three classes of accidents, rates were reduced by bike lanes in six accident classes and increased in one class. The frequency of accidents influenced by bike lanes was reduced by 53% overall, and the frequency of all accident types combined was reduced by 31% on bike lanes, demonstrating a positive effect of bike lanes on safety.

by Dale F. Lott; Donna Y. Lott
Publ: Journal of Safety Research v8 n4 p171-9 (Dec 1976)
1976; 5refs
Presented in part at the Transportation Res. Board 55th Annual Meeting, Jan 1976.
Availability: See publication

HS-020 120

GASOLINE CONSUMPTION

Tables and analyses of gasoline consumption in the U.S. are presented. A breakdown of gasoline by mode for highway use and by sector for nonhighway use shows that highway transportation accounts for over 96% of the total gasoline consumption in the U.S. The automobile is the major user, consuming about 73% of the total. A breakdown of the percent highway gasoline use by mode and sector shows that the automobile

consumes about 76% of the highway gasoline used annually, and that most automobile travel occurs in the private sector and consumes over 63% of the total highway gasoline. A look at automobile gasoline use 1970-85 shows that, due to supply shortages and higher prices during the oil embargo, gasoline consumption fell in 1974 to about 1972 levels. Estimates based on continued higher prices show consumption increasing again at an annual rate of 2% and 3%. Historical and forecasted total gasoline consumption and the annual rate of growth for each are tabulated. Regional total and per capita gasoline use for 1972 is tabulated and shows that total gasoline consumption varies by as much as 52% between regions. A ranking of 1972 gasoline consumption by individual states shows that Wyoming followed by Nevada are the top consumers. A breakdown of automobile miles traveled by trip and by purpose for 1974 shows that driving related to earning a living consumes over 40% of the total miles traveled. Estimates of average gasoline expenditures and the percentage of income spent on gasoline for five yearly income groups from $3,000 to $15,000 are tabulated. Of the five groups, the lowest income group pays the largest percentage of their income for gasoline, the percentage of income spent on gasoline declines as income increases.

by John Hemphill
Federal Energy Administration, Office of Transportation Programs, Washington, D.C. 20461
Rept. No. FEA/D-75/652; PB-246 220; 1975; 13p 8refs
Availability: NTIS

HS-020 121

DETERMINING THE TRAVEL CHARACTERISTICS OF EMERGENCY SERVICE VEHICLES

A procedure for determining the travel characteristics of emergency service vehicles involves conducting an experiment to collect data on a large number of responses to determine the relationship of travel time and travel speed to travel distance and time of day for emergency vehicles responding to calls for service within a municipality. The resulting empirical travel characteristics are important input parameters for many mathematical models that can be used to study the deployment problems of municipal emergency service systems. The procedure also involves analyzing the data collected using a computer program written in FORTRAN called the Travel Time Analysis Program. Instructions and data collection forms are provided for conducting the experiment, and the computer program is described, including the input data and output reports. The program estimates the relationship between travel time and travel distance using various regression methods and by fitting several curves to the data. The effects of weather and traffic conditions on travel speed are also examined. Travel time estimates can be used to evaluate the effectiveness of alternate deployment policies, to compare the performance of the emergency service agency over several regions of a city, or to provide planners or administrators with an idea of the quality of emergency service being provided. Several techniques for estimating travel distance are reviewed, for example, distance can be measured on a map by following the actual route of response. Distances can be estimated by computer by superimposing a rectangular grid on a map of the city and storing this grid in the computer. Then, any point in the city can be identified by a pair of grid coordinates. The distance between two points can then be estimated using a function of these coordinates. The average response distance for estimating travel time from travel distance are presente A user's manual for the Travel Time Analysis Program is pr vided, and includes a program listing, a description of th input data, a detailed explanation of the output, and a samp printout.

by Jack Hausner
New York City Rand Inst., 545 Madison Ave., N.Y. 10022
Contract HUD-H-2164
Rept. No. R-1687-HUD; PB-250 460; 1975; 76p 9refs
Availability: NTIS

HS-020 122

SOME APPROACHES TO A FAILURE PROOF TIRE

The flat tire problem has three alternative solutions: the t must not lose inflation pressure or go flat; if the tire goes fl it must be simply repairable and reinflatable without recou to a jack, preferably without requiring the driver to get out the car; or the tire can satisfactorily perform in the run f condition, the DeNovo approach. Although instant repair a reinflation can be done successfully at the present time, th are still formidable problems, making this approach m remote and inaccessible than the other two. To keep a t from losing air, a puncture sealant must have a composit that is capable of short range viscous flow, but highly ela insofar as long range permanent displacement is concerned, stable and able to function over a wide range of ambient t peratures, capable of effective application, whether spra on or built into the raw tire. Currently, spraying appears adequate application. Such a sealant has been developed meet these qualifications. Because rapid air loss events thought to arise chiefly from puncturing objects that h been working in the hole and enlarging it by erosion or rut to the point where they can no longer be gripped by the carcass and are flung out, laboratory tests have t developed to reflect this rationale. Four types of testing h been done: two puncture sealant high-speed nail throw tests and two puncture sealant nail-in tests. Such tests are ful preliminary guides, but field testing must follow. Field t for some 20,000,000 vehicle miles showed puncture sealan be quite effective for two reaons: in the experimental gr with puncture sealants, some punctures occur that are manently sealed and escape detection altogether; and in experimental groups with puncture sealants, the air lo usually much more protracted, allowing for an excellent portunity to avoid a down time event if the driver is ale detect a slow air loss. Such detection could be provided reliable low pressure warning indicator which lights up an light on the dashboard. Use of such a sealant and an ac panying indicator would eliminate the need for a spare tir jack, and mounting to some 50 pounds, plus several hur lbs. of metal required to package the spare tire.

by R. H. Snyder
Uniroyal Tire Co., Tire Technology
Rept. No. SAE-760741; 1976; 10p
Presented at the Automobile Engineering Meeting, Dearb 18-22 Oct 1976.
Availability: SAE

ATERIALS DEVELOPMENT IN CHASSIS AND ODIES

aterials changes are necessary in order to meet the Federal eet average fuel mileage of 27.5 mpg (11.7 km) scheduled for 85. Plastics and aluminum will replace some steel com- nents. New materials under development include formable oys of steel and aluminum, and fiberglass or glass/resin mposites. A major advance in plastics technology is a ther- oplastic stamping process using unreinforced (solid state) olypropylene sheet by Ford Motor Co. in which the problem springback is controlled by die development. The other oblems of thermoplastics stamping processes are memory d visually unacceptable surface defects. Reinforced olypropylene sheeting, called Azdel, is being used by .R.T.L. and by SMC in a variety of ways including as tainer panels. New thermoplastics materials under develop- ent include PBT from G.R.T.L., using a new resin; HMC d XMC from PPG; and SMC-II from Owens-Corning iberglass. Improvements are needed in in-mold coating and rocessing methods before such high-strength composites can place SMC. The major design factor in high-strength com- osites for bumper reinforcements is modulus. As for inner oor reinforcement, problems include rigidity improvement ithout undue thickness, and loss of strength due to fiber rientation around holes, ribs, and bosses. Molding versus onding of multiple parts is debated within the industry. Budd a leading proponent of multiple piece assemblies. The modu- s problem of glass-reinforced structural composites may be olved by inclusion of aromatic polyamide (Kevlar 49) or gra- hite fiber. New production systems are needed for epoxy ystems and for hybrids between them and the high modulus lass composites, e.g. inclusion of graphite fibers. Lead-tin older will soon be replaced by plastic body solder. The body older used by Chrysler Corp. is an elastomeric-modified oxy for which application, cure, and finishing are described. dvantages of the new solder are probable reduction in repair cidence due to less joint heating, easier grinding and finish- g, weight and cost savings, greater flexibility at low tempera- ures, and suitability for use between metals having dissimilar ates of thermal expansion. Newly developed aluminum alloys or use as body sheets include Reynolds' 5182 and 5182SSF, nd Alcoa's 6009 and 6010. Aluminum as an exterior skin com- onent needs to be slightly thicker than steel, needs to have a lightly larger blank size, has more severe springback which mits panel curvature (more generous radii are needed) and recludes sharp bends, and has lower ductility which neces- itates more gradual shape development. Alcoa's new alu- inum-manganese-silicon alloys have a unique phenomenon of recipitation hardening when brought to high heat (as in a aint oven). Resulting strengths are higher than that of any ther automobile body sheet. These new alloys are also more conomically feasible than earlier aluminum alloys. The steel ndustry is working on a high-strength cold rolled steel to be sed in thinner gages. A decrease in gage would decrease veight, provide good yield strength, but tend to dent. General Motors and some Japanese steelmakers are working on dual hase steels which involve the simultaneous existence of two icrostructures, e.g. ferrite and Martensite. General Motors' hermomechanically Treated (TMT) high-strength steel main- ains good tensile strength but needs improvement in yield trength.

by Carl A. Gottesman
Publ: Automotive Industries v155 n10 p17-28 (1 Dec 1976)
976
Availability: See publication

HS-020 124

MATERIALS TRENDS IN ENGINES AND POWER TRAINS

Graphite reinforced plastic is one of the new materials being considered for automotive applications. The Ford Motor Co. has been testing a graphite composite driveshaft in one of its Granadas with good results. The shaft is approximately 2.75 inches in diameter, with a wall thickness of 0.1 inch, and is five pounds lighter than an 18 pound standard driveshaft. The Granada driveshaft has undergone over 15,000 miles of road testing without problems and the only special concession to the composite shaft was the addition of a heat shield between it and the catalytic converter. Graphite fibers provide the fatigue resistance which is a key factor in many automotive applications. If the price of graphite fibers drops from its current price of $32.00 per pound to around $3.00 per pound, there will arise a multimillion dollar automotive market for the material in the 1980's. The use of the more traditional fiberglass reinforced plastics for engine components is expected to rise also. Uses currently include: Chrysler's Lean Burn engine computer module housing; various General Motors (GM) Hydramatic transmission components, such as accumulator pistons, governor gears, and intake and vent pipes; GM's torque converter covers; Chevrolet's timing belt cover; and GM's fan shroud assembly. Aluminum is gaining increased usage in automotive applications. Ford is using aluminum for its air cleaner housings. The air cleaners, made of 5182 aluminum alloy, require no painting and can save 5.5 pounds over all-steel versions. The 1978 model year auto will have an all aluminum rear engine cover plate, and other possibilities for aluminum sheet are the differential housing cover, engine mounting brackets, belt torsioning brackets, and rocker covers. Chrysler's experimental car, the Charger XL, uses aluminum extensively in the engine and drivetrain reducing its weight substantially. The Dart Lite and the Plymouth Feather Duster were Chrysler materials cars last year. This year, the same transmission, which is 33 pounds lighter through the use of aluminum, is offered as part of an economy option. Some manufacturers will combine various materials such as aluminum and cast iron for many engine applications to save in manufacturing costs and to reduce weight. Although the all aluminum engine in the Vega has had durability problems, GM's use of aluminum is still expanding. New uses for old materials are saving weight also. Pontiac's new 301 cubic inch V8 powerplant featuring all new cast iron design, combined with special manufacturing techniques, saves 127 pounds over the 350 cubic inch power plant it replaces. Oldsmobile has redesigned the castings on its engines with a similar eye toward eliminating material and reducing weight. High strength alloy steel, another old standard, can be used in thinner sections to save weight, and can be coupled with aluminum in several continuing exhaust system applications.

by Richard J. Fosdick
Publ: Automotive Industries v155 n10 p33-40 (1 Dec 1976)
1976
Availability: See publication

HS-020 125

FUEL CONSERVATION MEASURES: THE TRANSPORTATION SECTOR. FINAL REPORT. VOL. 2

An investigation of potential transportation fuel savings associated with both increased fuel efficiency and variations in urban form is presented, as they relate to the State of Texas. Improving the fuel efficiency of transportation requires reversing the existing trend toward less fuel efficient transportation. Urban person movement may be accomplished more fuel efficiently by: improving vehicle efficiency through increasing the average miles per gallon associated with auto travel; by increasing the availability of mass transit; by instituting other conservation measures such as providing incentives for car pooling, walking, and bicycling, and by improving traffic flow through engineering design. The fuel efficient movement of urban goods may be accomplished by providing incentives to increase load factors, to increase the average size of load per delivery vehicle. Changes in urban development that will encourage increased transit ridership will reduce the demand for urban transportation fuels. Rail transit is the most efficient mode, bus transit is the next most efficient, and the auto is the least efficient. If increased mass transit usage is to be fostered, actions should be taken to increase the population density of urban areas, since a dispersed urban development cannot be served efficiently by mass transit. The actions taken would need to be quite strong, as the recent trends in urban development have been toward lower population densities. Increasing transit availability without providing corresponding alterations in urban form may have little or no effect on transportation fuel consumption. Transportation fuel consumption per capita decreases significantly as population density increases. Alteration of automobile design is discussed as a means of improving auto fuel efficiency. Due to the large percentage of transportation fuel used by the private auto, improved fuel efficiency can significantly reduce the volume of fuel consumed by transportation. A 20% increase in auto fuel efficiency would reduce total transportation fuel consumption by 13%. Auto weight is the primary factor influencing fuel economy, and the trend has been toward heavier vehicles. Correspondingly, the trend has also been toward poorer fuel economy. Emission controls have not adversely affected the fuel economy of all vehicles. For vehicles weighing 3500 pounds or less, fuel economy has actually been improved by emission control devices. At present, the fuel economy experienced by a 1975 Chevrolet Chevelle is representative of the average vehicle on the road. Shifts to more fuel efficient vehicles can greatly increase fuel efficiency.

by Ron Holder
Texas A and M Univ., Texas Transportation Inst., College Station, Tex.
Contract GEAC-GI44085; GEAC-SIA73-05812
Rept. No. PB-243 325; 1975; 98p
Proj. S/D-9. Vol. 1 is HS-020 100.
Availability: NTIS

HS-020 126

WHEEL LOCK CONTROL. STATE-OF-THE-ART

The function and operation of the wheel lock control system designed to aid in retaining vehicle directional stability during monitors the controlled wheel's speed, and if an impen wheel lockup is detected, the brake pressure is reduced the wheel is not locked or tending to lock, at which time brake pressure is allowed to return to the driver demand p sure. If the driver demand pressure creates excessive b torque for the road and load conditions, the system modul the brake pressure until a low vehicle speed is reached, cally somewhat below ten mph. Through the reduction of brake pressure, the wheel lock control system prevents tinuous wheel lockups while allowing the controlled whe contribute braking and lateral stabilizing forces to the veh The primary forces which act on a vehicle to determin path during a braking maneuver are tire normal force, braking force, and tire lateral force. They occur at each r tire interface. Tire braking force is commonly expressed ratio with the tire normal force, typically expressed as a f tion of tire slip. Tire lateral force can also be described function of wheel slip. The major components of the sy are brake pressure modulator, electronic control module, wheel speed sensor. Statistical data appended include gr illustrating tire braking force characteristics, surface vari of tire braking force characteristics, tire lateral and bra force characteristics, wheel lock brake torque modulation, full brake pressure wheel lock control stop.

by Robert A. Grimm; Richard J. Bremer
General Motors Corp., AC Spark Plug Div.
197?; 7p 7refs
Availability: General Motors Corp., Environmental Activit Staff, General Motors Technical Center, Warren, Mich. 48

HS-020 127

INVOLVEMENT IN TRANSPORTATION THROUG CAREER AND CURRICULUM PLANNING. SEMIN PROCEEDINGS, JACKSONVILLE, FLORIDA, JUN 18-22, 1973

The 29 papers presented at the seminar discuss aspects o economic, social, and political significance of transport with emphasis on transportation/distribution, prices and t portation, economic development and transportation, urba tion and transportation, and political contributions to tran tation. The discussions centering around the topic of tran tation services cover intermodal activities, progress in th line sector, progress and problems of the United Parcel vice, and the functions of warehousing. An overvie government and transportation is presented which focus government as a promoter and regulator, and as such as plies to Amtrak, to aviation, and to the history and func of the Florida Public Service Commission. Some transp tion issues and answers which are discussed include: prob associated with urban movement of people and goods; as of highway, railroad, and mass transit safety in Florida vironmental and ecological considerations; and the Sta Florida's position on effective and efficient transportatio vices. Some of the available career opportunities in transp tion which are discussed include those in railroads, sea cargo transportation, industrial traffic management, and p service. A discussion of transportation and the curriculu cludes papers dealing with education and career opportu transportation as subject matter for curriculum inclu transportation and economic development, government transportation, some social and environmental considera

the summary of findings and recommendations of the seminar's curriculum study group.

by Jay A. Smith, Jr., ed.
University of North Florida, Dept. of Transportation and Logistics, Jacksonville, Fla.
Contract DOT-OS-30114
Rept. No. DOT-TST-76-1; PB-244 253; 1974; 137p
Seminar held at Univ. of North Florida, Jacksonville.
Sponsored by Dept. of Transportation, Office of Univ. Res.
Availability: NTIS, $3.75 PC/$2.25 MF

HS-020 128

HIGHWAY DESIGN FOR MOTOR VEHICLES -- A HISTORICAL REVIEW. PART 8: THE EVOLUTION OF HIGHWAY STANDARDS

The use of road design standards dates back to the Romans. In the U.S., until the 19th century, standards were established primarily by consensus. In the 19th century, with the writings and practices of eminent roadbuilders, and manuals of eminent college engineering professors and the U.S. Corps of Engineers, practices derived from recommendations from these sources rather than consensus. States set up their own highway departments starting about the turn of the century. The Federal government entered the picture with the Federal Aid Road Act of 1916, but even though the law called for the Secretary of Agriculture's approval of "substantial" highway projects, no Federal standards were established, and the Secretary's recommendations were based on accepted State practices. In 1914 the American Association of State Highway Officials (AASHO) was formed to provide a clearinghouse for standards, becoming the necessary link between the highway engineering technician and the road builder. AASHO standards are now accepted countrywide and have had a large influence on the standards developed worldwide. Whereas in the past standards were developed based on the importance of the road, currently most engineers acknowledge that traffic is the primary determinant for road standards. Elements related to topography and character of traffic were introduced into AASHO standards and are the basis on which geometric road standards are presently based. AASHO, furthermore, has developed highway bridge standards that include standard live loadings to measure the capacity of bridges to support loads for trains and traffic. AASHO created the Committee on Roads and Bridges, which has published "Standard Specifications for Highway Bridges and Incidental Structures." This publication, updated frequently, specifies four standard classes for highway bridges based on load frequency and proposes three standard live loadings to simplify computation of stresses for each of three of the four bridge classes. Bridge design specifications in other countries all feature standard design loading with some individual variations, but basically all countries hold to the tenet that the type of loading that produces maximum stress controls the design. AASHO bridge standards have been adopted or copied in about two-thirds of all countries, making them virtually the world standard in bridge design.

by Frederick W. Cron
Publ: Public Roads v40 n3 p93-100 (Dec 1976)
1976; 9refs

HS-020 129

1974 BRAKE PERFORMANCE LEVELS FOR TRUCKS AND PASSENGER CARS

Braking performance tests were conducted in Maryland, Michigan, and California by the Bureau of Motor Carrier Safety (BMCS) on 1,200 single unit trucks and combination vehicles and, for comparison, 366 passenger cars. Information obtained from the testing is expected to be used to promote improvement in the general level of brake performance, to serve as a basis for revising brake performance standards, to provide current motor vehicle performance data that can be used to establish highway design standards, and to show different levels of actual brake performance for the different types of vehicles using the highways. All vehicles were selected at random from general highway traffic. For each, a complete description was recorded and three emergency stops were made from 20 mph. Braking performance was measured in terms of brake system application and braking distance (BSABD). The primary instrumentation was a test wheel equipped to measure speed and distance with accuracies of plus or minus 0.1 mph and plus or minus 0.1 ft., respectively. In the analyses of test data, vehicles were classified by vehicle type, manufacturers' Gross Vehicle Weight Rating (GVWR), and actual weight of the vehicle at the time of the test. Braking performance results were compared with the performance requirements of the Federal Motor Carrier Safety Regulations (FMCSR) (2), the Uniform Vehicle Code (UVC) (3), and with the results of previous studies. These comparisons are presented, primarily in the form of cumulative frequency curves and percentile plots derived from these curves. A decline in braking performance, from 20 mph since 1963, was found for passenger cars. Several factors can account for this decline: significant increases in vehicle weight, the increased use of the vacuum booster (power) brakes, and the substantial conversion to disc brakes on front wheels. Single unit trucks, as a group, showed the largest decline from the 1963 braking performance levels. Most categories of combination vehicles either declined or remained essentially the same in braking performance during this period. Large percentages of commercial vehicles on the highways are not capable of meeting the applicable stopping distance requirements from 20 mph specified in FMCSR. It is believed the majority of these vehicles could meet or exceed the FMCSR requirements if properly maintained. It is recommended that Federal and State vehicle inspection programs put increased emphasis on activities dealing with brake system maintenance and adjustment, and that tests similar to those conducted in 1974 be repeated every five years to determine whether the negative trend observed in 1974 has been reversed and to determine the effect on vehicles-in-use of Federal Motor Vehicle Safety Standard No. 121.

by Paul A. Winter
Publ: Public Roads v40 n3 p108-15 (Dec 1976)
1976; 7refs
Condensed from the final report "1974 Brake Performance Levels for Trucks and Passenger Cars" by Paul A. Winter, Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C., 1976.
Availability: See publication

MODELS DURING THEIR FIRST TWO YEARS, 1974 MODELS DURING THEIR FIRST THREE YEARS

Automobile insurance data are presented which describe variations in both frequencies and size of collision claims for damage to private passenger vehicles from three model years. The statistics from collision coverages were supplied by seven insurance companies: Allstate, Kemper, Liberty, Nationwide, Prudential, State Farm, and Travelers. The results for the 1976 models were based on more than 700,000 insured vehicle years of exposure, those for the 1975 models on more than 1.8 million insured vehicle years, and those for the 1974 models on more than four million. In general, the greater the exposure of a type of vehicle, the more confidence can be placed in the results for it. Data are presented in tabular form. Standardized data for 1976 model year passenger vehicles from twelve domestic and nine import makes include results for individual vehicles grouped into eight market classes. The individual results are listed in ascending sequence of average loss payment per insured vehicle year. A considerable range in the results with each body style and market class was noted, and claim frequencies varied substantially between market classes. Comparisons between body styles showed a continued trend toward higher average loss payments for two door models than for four door models. Appended data provide claim frequency and average loss payment details by make and series. Data for 1975 models during their first two years include summarized standard results for twelve domestic and eight import makes, and results for individual vehicles grouped into eight market classes. Appended data are presented for claim frequency and average loss payments before standardization, and standardized results for 1975 vehicles separately for each of the two years since their introduction. Standardized results for 1974 models are summarized for twelve domestic and three import makes during their first three years. Results for individual vehicles grouped into eight market classes and for each of the market classes are presented for 1974 models also. Appended data include detailed claim frequency and average loss payment results before standardization and standardized results for 1974 vehicles separately for each of the three years since introduction.

Highway Loss Data Inst., Watergate Six Hundred, Washington, D.C. 20037
Rept. No. RR-HLDI-R76-2; 1976; 80p
Availability: Corporate author

HS-020 131

1975 CRC 0COORDINATING RESEARCH COUNCIL0 OCTANE NUMBER REQUIREMENT SURVEY

A statistical survey of 503 (454 U.S. and 49 imported) 1975 model cars was conducted which included determinations of maximum octane number requirements under full and part throttle operating conditions, and observations of surface ignition knock and rumble. Maximum octane number requirements for all cars tested in the survey, and for U.S. cars separately, are presented in table form for 50% and 90% car satisfaction levels. Incidence of part-throttle knock was considerably higher in 1975 model cars compared to 1974 model cars. Maximum requirements occurred at part throttle in 3.2% of all 1975 model cars with primary reference fuels (PR), 16.3% with average sensitivity full boiling range unleaded fuels (FBRU), and 23.2% with high sensitivity full boiling range unleaded fuels (FBRSU). Thirty-eight percent of the 1975 model weighted population was found to knock on tank fuel compared to 28% in the 1974 population surveyed. There were nine reports of cars with surface ignition knock as compared to two in the 1974 survey. Octane number requirements were determined in 423 U.S. and imported cars over the speed range using primary reference fuels. Maximum requirements at each satisfaction level occurred at 2,100 to 2,150 rpm. Average laboratory octane number ratings and blending data for the FBRU and FBRSU fuels are appended in table form. Sensitivities of the 1975 full boiling range reference fuels are summarized, and a comparison of sensitivities of 1974 and 1975 FBRU fuels is presented. Octane number requirement data were used to prepare satisfaction curves for the sample of all 1975 cars, and for U. For allS. and imported cars separately. U.S. and imported cars, distributions of maximum Research octane number requirements are plotted, as are maximum Motor octane number requirements, and maximum octane number requirements for all three fuel series. Other tables illustrate the octane number requirement distribution for 1975 U.S. cars including imported models compared with corresponding 1974 model year data for PR fuels, the 1975 and 1974 maximum octane number requirement results. In general, the 1975 model year PR octane number requirements were slightly lower than those of the 1974 models at the higher car satisfaction levels. With FBRU fuels, both Research and Motor octane number requirements of the 1975 cars were somewhat lower than those of the 1974 cars over the satisfaction range. In the U.S. car group, the 1975 model year PR requirements were about the same as those of the 197 models. On FBRU fuels, Research and Motor octane number requirements of the 1975 models tended to be slightly lower than those of the 1974 models. On PR fuels, the 1975 requirements were 0.4 octane number higher at the 50% car satisfaction level and 0.2 octane number lower at the 90% satisfaction level than the 1974 requirements. The Research octane number requirement distributions for imported cars are shown in table form for PR, FBRU, and FBRSU fuels. The engine speed of maximum octane number requirement at 90% satisfaction was 2,150 rpm for all U.S. and imported cars, and varied from less than 2,000 to 2,900 rpm for the nine selected models.

Coordinating Res. Council, Inc., Octane Number Requirement Survey Group, Analysis Panel, Thirty Rockefeller Plaza, New York, N.Y.
1976; 185p
CRC Proj. CM-105-75.
Availability: Corporate author

HS-020 133

STAPP CAR CRASH CONFERENCE (20TH) PROCEEDINGS. OCTOBER 18-20, 1976. DEARBORN MICHIGAN

A compilation of papers discussing various aspects of c crashes involving human injury is presented. The majority papers deal with experimental studies using dummies, cadav subjects, live human subjects and live animal subjects; oth papers include discussions of the safety performance of ce tain windshields, restraint systems and bumpers, procedur for estimating human injury tolerance levels and for predicti impact injuries, and a new technique for cineradiographic an ysis of biomechanical impact and kinematic study.

Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096
Rept. No. SAE-P-66; 1976; 783p 319refs
Includes HS-020 134--HS-020 158.
Availability: SAE

HS-020 134

THE EFFECT OF DURATION, RATE OF ONSET AND PEAK SLED ACCELERATION ON THE DYNAMIC RESPONSE OF THE HUMAN HEAD AND NECK

A series of human experiments was conducted to measure the response of the head and the first thoracic vertebrae to the parameters of duration, rate of onset and peak acceleration of the sled. Each subject was run at three conditions defined as high rate of onset-long duration (HOLD), high rate of onset-short duration (HOSD) and low rate of onset-long duration (LOLD) at peak accelerations of 6, 10 and 15G. Results show that peak head angular acceleration increased with increased sled acceleration peak, onset and duration. Peak head angular velocity increased with sled acceleration peak and duration but was not affected by sled acceleration onset. Peak linear resultant acceleration at the head center of gravity increased with sled acceleration, peak, onset and duration. Peak horizontal linear acceleration at T1 (first thoracic vertebral body) increased with sled acceleration peak and onset. The onset defined at T1 was found to be approximately the same as the sled onset for low onset conditions and much attenuated relative to the sled for the high onset condition. This was undoubtedly the result of the dynamics of the restraint system and chest interaction. Regression on the parameters of T1 acceleration show that the peaks of head angular acceleration, angular velocity and linear resultant acceleration were dependent on the first peak and duration of acceleration at T1. Onset of acceleration at T1 had no effect. It is suggested that the effects of onset either manifest themselves by increasing the horizontal acceleration at T1 or through a parameter which is highly correlated with this effect at T1. Computations from a formerly developed head/neck model indicate that the model in this study was consistent with the data in the relative effects of onset and duration, that the model head angular acceleration correlated well with the extension angular velocity (head link relative to neck link) at the extension limit assumed in the model, and that no method of measuring neck compliance, neck length and head moment of inertia in a human volunteer has been satisfactorily validated.

by C. L. Ewing; D. J. Thomas; L. Lustick; William H. Muzzy, 3rd.; G. Willems; P. Leonard Majewski
Naval Aerospace Medical Res. Lab. Detachment, New Orleans, La. 70189
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p1-41
Rept. No. SAE-760800 ; 1976; 12refs
Availability: In HS-020 133

HS-020 135

COMPARISON OF KINEMATIC PARAMETERS BETWEEN HYBRID TWO HEAD AND NECK SYSTEM WITH HUMAN VOLUNTEERS FOR -Gx ACCELERATION PROFILES

Significant kinematic parameters of the head are compared between a Hybrid Two head and neck (per Part 572, Federal Motor Vehicle Safety Standard 208) and human volunteers subjected to the same -Gx sled acceleration profiles. Comparison time profiles between the dummy and human subjects for components of linear acceleration, velocity, and displacement of the head center of gravity and the first thoracic vertebral body (T1) anatomical origin, as well as components of angular acceleration, velocity, and displacement of the anatomical coordinate systems are presented for 6, 10 and 15G sled acceleration in the -Gx environment. In an overall sense the kinematic response of the dummy is found to be significantly different from that of human subjects in all variables compared. However, at certain times within the response, compatibility is evident. Kinematic variables of the dummy compare favorably with the human subjects up to the time of peak angular velocity. Subsequent to this time, differences in angular acceleration, angular velocity, angular displacements, and linear acceleration of the head between the dummy and human subjects become more pronounced. The methodology employed in this study appears to be a very acceptable way of comparing data between candidate dummy head and neck designs and human subjects in the same -Gx acceleration profile. The reproducibility of the dummy is excellent in all the variables of this study at all G levels. The profile and level of peak head angular acceleration and angular velocity in the dummy agree well with the average human data up to the time of the first zero of angular acceleration (peak angular velocity). The most noticeable difference in the comparison between dummy and human profiles is the large negative angular acceleration spike which occurs in the dummy and is much attenuated in the human subjects. This large negative spike causes the peak head angle in the dummy to occur earlier and to be significantly less than that which occurs with human subjects. The resultant acceleration of the head center of gravity profile for the dummy has a much less prominent valley between the two peaks characterizing this curve than that which occurs with most human subjects (first peak significantly lower at 10 and 15G sled levels than those for human subjects, second peak in resultant acceleration profile much higher for the dummy at 6 and 10G sled levels and within human range at 15G). The peak horizontal acceleration at T1 for the dummy is much higher (more dynamic overshoot) at the 6G level and the drop-off subsequent to the first peak much more pronounced than that of the human subject profiles. This discrepancy becomes less with increasing sled G level. Because onset increased with G level in this study the results suggest that the essentially infinite stiff chest of the dummy is a better representation of human chest characteristic at high onset. The head angle relative to torso angles is significantly greater in the human runs than for the dummy. The displacement of the head center of gravity relative to the neck anatomical origin in the laboratory Z direction is significantly different and in the opposite direction (based on analysis at the 10G sled levels).

by William H. Muzzy, 3rd.; Leonard Lustick
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Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p43-74
Rept. No. SAE-760801 ; 1976; 13refs
Availability: In HS-020 133

HS-020 136

THE DESIGN AND USE OF THE TRRL 0TRANSPORT AND ROAD RESEARCH LABORATORY0 SIDE IMPACT DUMMY

The design and construction of a side impact dummy and its preliminary calibration using real life accident data and its use to develop safer car designs are discussed. The dummy has been designed specifically for measuring the levels of protection afforded to occupants of vehicles struck in the side approximately perpendicularly and in the vicinity of the occupants. It has force transducers fitted to measure lateral

loadings at locations corresponding to the shoulder joint, four stations on the rib cage, the iliac crest and the hip joint. Accelerometers may be fitted in the headform, upper thorax and pelvis. The results using this dummy are repeatable, and the dummy has not suffered damage during testing and thus appears to be practicable for regulatory as well as research testing. The durability partly stems from the decision to build it more rigidly than the human frame on the premise that this does not distract from its ability for assessing the suitability of energy-absorbing, padded structures likely to strike it. The dummy has been tentatively calibrated by comparing loadings recorded on it in test situations matching similar accident situations with known injuries to car occupants struck in the side. Results suggest that vehicles giving loadings on the dummy below the following values are relatively unlikely to injure occupants struck in the body in side impacts into their cars. The suggested human tolerance equivalent loadings are as follows: shoulder lateral loading, 7 kN (1575 lb f); rib lateral loadings at each of four simulated ribs, 1 kN (225 lb f); and pelvic lateral loading (hips plus iliac crest), 6 kN (1350 lb f). The dummy has been used to develop the experimental safety versions of the Leyland Marina car shown at the 1974 5th ESV (Experimental Safety Vehicles) Conference. It enabled the internal face of the door structure to be padded to meet the different requirements for pelvic, chest and shoulder impact. At the same time it showed the need to use stiffened side sill structures on the struck car and matching low front bumpers on the striking car to reach side impact conditions for 48 km/h (30 mile/hour) perpendicular car-to-car impacts which were well below the suggested tolerance levels for human occupants.

by J. Harris
Department of the Environment, Transport and Rd. Res. Lab., London, England
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p75-106
Rept. No. SAE-760802 ; 1976; 5refs
Availability: In HS-020 133

HS-020 137

RESULTS OF CADAVER AND ANTHROPOMORPHIC DUMMY TESTS IN IDENTICAL CRASH SITUATIONS

An experimental program is discussed wherein fresh, unembalmed cadavers and anthropomorphic test dummies (ATD's) were exposed to identical crash situations with a view toward a better understanding of the role of the cadaver test in the design of restraint systems. Results include tests conducted on the Calspan HYGE acceleration sled and full-scale car crash tests using belt restraint systems and air bag systems. Cadaver test data obtained include head and chest triaxial accelerations from externally mounted sensors, chest deflections and belt loads. Cadaver test data also include arterial and lung pressure measurements as well as X-ray and gross necropsy evaluations. Dummy test data include normally measured internal triaxial head and chest accelerations. High-speed movie coverage produced cadaver and dummy kinematic results. The results of these experiments clearly demonstrate that cadaver testing should play a significant role in restraint system design, development and evaluation. Specific cases were shown wherein dummy results were not capable of locating problem areas of restraint systems which were evident from the cadaver results. It is felt that cadaver testing and dummy testing can play complementary roles in restraint development. As cadaver measurement and techniques become better defined, the roles of each of these human surrogates will become more clear. Development of cadaver measurement and test techniques, it is felt, should be continued, particularly with regard to supplementing other means of restraint system evaluation. The results of these experiments suggest that the "survivability" of present ATD's may not be either necessary or sufficient to demonstrate restraint effectiveness and that "survivability" of the cadaver may not be necessary but does appear to be a sufficient condition to demonstrate restraint effectiveness. Further study is required to investigate these hypotheses.

by Michael J. Walsh; David J. Romeo
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-5-01017
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p107-31
Rept. No. SAE-760803 ; 1976; 4refs
Availability: In HS-020 133

HS-020 138

DYNAMIC DUMMY BEHAVIOR UNDER DIFFERENT TEMPERATURE INFLUENCE

Dynamic dummy behavior under different temperature influence was studied. Dummy component calibration tests were performed as specified in 49-Part 572 (Federal Motor Vehicle Safety Standard 208) with temperature as the independent variable. In head drop tests, an increase occurred in the deceleration between 80° F and 110° F. In this range the head skin was so weak that the skin was not able to absorb the high peaks. Above 110° F, peak deceleration fell off rapidly. It is thought that reduced head skin friction causes slippage and rotation; also, temperature sensitivity of the accelerometers which show approximately 3% lower readings at 140° F, is an additional influence. In neck pendulum tests, all measured values increased with temperature. In thorax tests, all three dummies tested showed a tendency for the hysteresis to decrease and the deflection to rise with increasing temperature. Only the measured force showed a different trend. While the force measured at 22 fp/s was nearly constant, the force measured at 14 fp/s decreased. It appears that the weak dummy torso skin absorbs the forcepeak at 14 fp/s, but the influence decreases relatively at 22 fp/s. In order to analyze the temperature influence in the total restraint system, several tests were conducted with heated dummies on a horizontal sled. In five tests, the dummy temperature averaged 70° F; another five, the dummies were heated throughout to either 104° F or 140° F. The higher temperature tests resulted in exaggerated motion and higher mean values of resultant head and thoraxic accelerations, severity index and Head Injury Criterion (HIC). The sensitivity of the whole dummy to temperature changes in a belt/kneebar system sled test was less than the sensitivity of certain components, but the tendencies were similar. In general, film analysis showed greater forward movement resulted in facial contact with the steering wheel at higher temperatures, whereas the typical normal temperature simulation resulted in forehead contact with the wheel. It is assumed that soft tissue facial contact (e.g., the nose) resulted in lower peak forces and decelerations than would have happened with forehead contact. The velocity of the dummy head just prior to impact appeared to be higher for the heated dummy, although velocity could not be calculated directly (through integration), because of head rotation. It is thought possible that these two tendencies (higher velocity and facial contact versions forced head contact) result in unpredictable head accelerations, which can generate either higher or lower HIC values than the normal 70° F case. However, like the pi

senger dummy, the driver dummy shows a consistently higher chest resultant acceleration at higher temperatures which is related to temperature sensitivity of the accelerometers. The storage temperature of dummy spare parts and the dummy storage position also play a role in test results. It is pointed out, that despite the temperature influence, dummy tests are still very useful; and the existing disadvantages can be improved by adding a temperature stabilizer to the rubber parts to avoid aging of the material itself. In terms of total restraint system tests, either a temperature range must be specified for crash tests, or some tolerances should be added to the limits which are applied today to the restraint system by criteria related to dummy measurements.

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HS-020 139

A CRITICAL ASSESSMENT OF THE USE OF NON-HUMAN RESPONDING SURROGATES FOR SAFETY SYSTEM EVALUATION 0VEHICLE CRASH STUDIES USING HEADFORMS0

The principles and basic physical mechanisms necessary to ensure valid assessment of safety system performance through the use of nonhuman surrogates in vehicle crash studies are discussed, with particular reference to the helmet/headform surrogate situation. Attention is focused on this surrogate system because of the severity and high incidence of head crash-impact injuries and because of the, up till now, confusing anomalous and potentially dangerous behavior exhibited by experimental research investigations of soft (human-like) and hard (magnesium alloy) headform surrogates. The principles and physical mechanisms brought to light in the headform study are generally applicable to all surrogates used in the assessment of safety systems. It is not the intention of this discussion to suggest that nonhuman-responding headforms should not be used for assessment of a safety system's performance capabilities. Rather, what is strongly suggested is that the use of human-generated injury tolerance data with nonhuman-responding surrogates, as in Federal Motor Vehicle Safety Standard 218, is not appropriate for fair assessment of a safety system's performance capabilities and in fact could unfairly penalize a good safety system or force replacement with one of poorer quality. With respect to the anomalous behavior experimentally observed in comparisons of soft and hard headform/helmet evaluations, it is shown that the circumferential hoop-strength capabilities of a helmet could play a major role in stiffening soft headform response through the reduction of unconstrained squahing modes. As a result of the investigations it is concluded that rigid headforms do not allow for duplication of helmet damage and assessment of true level of protection afforded by a helmet: that the surrogate system used in a safety system compliance (based on human response injury tolerance data) test must also be of a human-responding type: that human responding surrogates must have deformation response characteristics such that the mechanical impedance and structural compliance (force, displacement, velocity, mass, stiffness, frequency relationships) matches that of human subjects: that if nonhuman-responding, rigid, headforms are to be used in compliance tests, than the human injury tolerance data used must be modified in some fashion to account for the potentially dangerous anomalous behavior experimentally observed; that current nonlinear finite-element numerical/computer techniques offer a viable cost-effective surrogate supplement for conducting parametric safety system response characteristics studies; and that basic biomedical research, particularly in the area of head/neck biomechanics and injury tolerance, must be rapidly expanded.

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HS-020 140

OCCUPANT PROTECTION IN LATERAL IMPACTS

The frequency, severity and type of injury sustained by occupants of cars impacted laterally are discussed using real-accident data, a discussion of the factors which determine the nature of these injuries is presented, and ways to improve occupant protection are proposed. A total of 296 lateral impact accidents were studied, consisting of those accidents resulting in an occupant trajectory between 2 and 4 o'clock or 8 and 10 o'clock (the longitudinal axis of the car coinciding with axis 6-12 o'clock, the front portion being directed towards 12 o'clock) and in a few cases those whose occupant trajectory is 11 or 1 o'clock, or 5 or 7 o'clock and when the wall has been directly deformed by the impact and struck by the nearside occupant. Each impact involves at least one injured car occupant. The distribution of side-impacted vehicles according to type of obstacle (other car, 66%; heavy truck, 8%; fixed obstacle, 16%; other 10%) is near the national French distribution; but the severity of injury sustained by the occupants (killed, 9.6%; severely injured, 26%; slightly injured or uninjured, 64.4%) is higher. Impact localization, intrusion into passenger's compartment, car speed variation, direction of occupant trajectory, and objects contacted by the various body areas are considered, and tabulated and graphical data from the accident sample are presented. Medical data analysis has been performed for 419 involved, injured, or killed occupants, and results are briefly discussed; tabulated data are given for AIS (Abbreviated Injury Scale). That there are insufficient data available from lateral impact studies to allow for the determination of the frequency for which any occupant protection measure would be efficient. A description of the conditions necessary for simulation of car-to-car impacts is given, and the following observations are made: speed variation in cars studied where people were killed or severely injured was slightly lower than the average obtained in other studies where speed variation was found to be greater than 37 km/h for 50% of accidents; the relative velocity with which the nearside occupant hits the intruded side was found to be higher than the speed variation of his/her own car: out of 100 fatal or severe injuries sustained by nearside occupants with intrusion, 50 occurred in cars whose speed variation was never beyond 29 km/h (0 impact speed of 54.5 km/h); from results of biomechanical tests, it is thought that measures combining the limitation of intrusion and internal padding with shock-absorbing materials should permit a lower risk of death or severe injury below speed variation of 29 km/h; it is thought advisable to continue research on head and neck tolerances in the assumption that energy-absorbing material would be ensured up

to shoulder height and would permit a notable shift of the head sideways; devices intended for limiting intrusion into passenger compartment may also alter trajectory of cars; lateral impacts against fixed and rigid obstacles account for more than one-third of lateral impact fatalities and should be avoided through a better arrangement of road substructure; and the main advantage of the safety belt is to avoid ejection during lateral impacts.

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HS-020 141

SAFETY PERFORMANCE OF SECURIFLEX WINDSHIELD

A new type of car windshield, the Securiflex windshield, was experimentally tested to evaluate its safety performance. The windshield consists of a special, thin, plastic inner surface attached to the inner surface of a three-layer windshield similar to the standard laminated windshield used in the United States. The windshield was designed to minimize lacerations from occupant impact to the windshield during a collision: the plastic coats the sharp edges of the broken glass, preventing or minimizing laceration. It was evaluated by comparing its laceration performance with that of a standard windshield in simulated barrier crashes at velocities up to 65 km/h, using a Peugeot 504 automobile. No lacerations were found to occur at velocities up to 65 km/h with the Securiflex. Lacerations as measured by chamois skins start at 20 to 25 km/h with the standard windshield. Lacerations measured with napa goatskin start at about 25 km/h with the standard windshield. No substantial penetration occurred with Securiflex windshields at velocities up to 65 km/h. The velocity at which lacerations occur was not reached, but is above 65 km/h. Penetration with the standard windshield started at about 35 km/h. Laceration of the chamois skin is considerably higher than for the napa goatskin at the same collision severity with the standard windshield. Performance of the Securiflex windshield is much better than the standard windshield in terms of lacerations and penetration. The standard windshield is slightly better than the Securiflex in terms of HIC (Head Injury Criterion), but the difference is not significant. The overall conclusion is that the Securiflex windshield provides complete protection from laceration in the Peugeot 504 at barrier collisions up to 65 km/h. It is further concluded that the Securiflex performance will be substantially better than the standard windshield in other vehicles, but the threshold of laceration and penetration and the absolute laceration and HIC values might differ from those reported herein.

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HS-020 142

SAFETY COMPARISON OF LAMINATED GLASS AND ACRYLIC GLAZING IN FRONT CAMPER WINDOWS

A safety comparison is made between laminated glass acrylic glazing in front camper windows, with reference to juries sustained by children riding on the bed over the when they strike the glazing material and/or are eje through the opening when forward force collisions oc These types of collisions simulated at velocities up to 30 showed the acrylic material to pose threats of neck and h injury and the laminated material to result in lacerations. E tions occurred with the acrylic that were not present with laminated windshields when correct glazing techniques v used. With poor installation procedures, ejections occurre both types of glazing materials. It is concluded that the way to avoid injury is to prevent the child from riding in over-the-cab bunk. If the child does ride there, his body should be positioned at an angle to the longitudinal axis of vehicle. Also, the front interior of the camper shoul padded to minimize injury. Among the five injury criteria sidered, laminated glass was substantially better in two of criteria (neck extension and ejection), slightly better in tw the criteria (lumbar extension and concussion potential) the acrylic was superior in terms of facial laceration pote The primary recommendation growing out of this study is necessity for a correct and careful installation of the win The installation of the glass or acrylic must be accompli with bonding or clamping so the glazing material will not out of the frame when struck. Furthermore, it is necessa install the window in the camper with sufficient fastenin the whole window frame and window will not be knocke of the vehicle. The use of wider aluminum retention (covering a larger portion of the glazing) and an incre number of sheet metal screws would decrease the proba of glazing bowing, frame pullout, and eventual glazing pul

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HS-020 143

DESIGN, TEST AND DEVELOPMENT OF A WHEELCHAIR RESTRAINT SYSTEM FOR USE I BUSES

The design, test and development of a contoured rear-f restraint couch which protects wheelchair-confined passe in simulated frontal barrier collisions at velocities of up least 25 mph and in simulated rear-end collision described. A cable system secures the wheelchair to the of the restraint couch and is automatically engaged whe wheelchair is backed against the couch. A three-poin system secures the passenger in rear-end collisions or elastic rebound in frontal collisions. Plastic deformation couch framework limits g-loadings on passenger and even during severe impacts. Some general recommend are presented. Further development work and testing be performed and survivability under rollover and side i conditions should be evaluated. The system shou qualified in frontal collisions up to 30 mph BEV (E

ated. The deployment of the belt system should be made as simple as possible to minimize the effort of the handicapped passenger. Quadraplegics would probably not be able to fasten the buckle on the existing system. Electrically operated wheelchairs should be tested on the WHAM-Three (Wayne Horizontal Acceleration Mechanism-Three) facility to evaluate the strength of the battery under impact and the added mass effect of the battery, motor, etc. Further impact studies are needed to optimize the strength of the restraint couch framework. Additional strength may be needed to survive barrier impacts at higher velocities than 25 mph but too stiff a structure will result in higher g-levels acting on the head and chest of the handicapped passenger. The Wayne State University campus will serve as a proving ground for evaluation of the system; feedback will be an invaluable source of information for making continued improvements of the system.

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HS-020 144

AUTOMOTIVE SEAT DESIGN AND COLLISION PERFORMANCE

Eighty-five laboratory full-scale force-deflection tests were conducted on passenger vehicle seats, foreign and domestic, for purposes of evaluating specific resistance to a collision environment and mechanisms of collision induced seat distortion. Evolution of seat and head support standards in the U.S. and Europe are presented with evaluation of their relative significance to the requirements of automotive seat collision performance. Intended headrest requirements are not met for many seats when headrest is in the retracted position. Passive restraint systems may be ineffective in multiple impact or upset frontal collisions while the cross-chest belt restraint system is effective. The foregoing research provided foundation for modification of a production automobile seat into an integral safety seat, based on a design concept that minimizes bending movements during collision. The modified seat was subjected to the same laboratory test procedure applied to the 85 nonmodified production seats and results of its performance are given. Design concepts are presented that would serve to mitigate undesirable seat distortions during collision and thus improve seat restraint capabilities without compromising the important factors of comfort and cost. The roof-to-floor anchored webbing for backrest crash attenuation simplifies seat structural requirements because bending moments are decreased more than ten-fold. By use of inertial reels this front seat conversion is accomplished without inhibiting rear seat access for two-door vehicles or backrest reclining or seat fore-and-aft positioning. Direct attachment of cross-chest, lap belt restraints to the seat minimizes uncontrolled belt slack and allows incorporation of belt prestressing and other restraint compliance improvements. The integral safety seat provides the basis for effective protective measures against direct side-impact collisions (three-point belt restraint system, deeply contoured seat, structural members between seat and outside door surface act to accelerate seat with occupant attached during initial contact and crush phase resulting in less abrupt acceleration of occupant, minimal slack between motorist and restraint system, protection from direct puncture and shear forces). The integral safety seat protective capability against frontal impacts is well established, and roof crush during rollover can be considerably reduced by taller and strengthened front seat backrests. Judged on the basis of initial cost, maintenance costs, functional reliability, exposure to dangerous malfunction or lack of effectiveness for many types of collision exposures, the integrated seat which includes integral cross-chest lap belt restraint comes out way ahead in comparison with the air bag.

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HS-020 145

CAR OCCUPANT FATALITIES AND THE EFFECTS OF FUTURE SAFETY LEGISLATION

An analysis of a sample of over 300 fatally injured occupants of cars involved in accidents mainly between 1969 to 1976 in urban, rural and highway environments of the United Kingdom is presented. When tested statistically on the bases of month of accident, day of week of accident, and age and sex of fatally injured occupant, the sample was not dissimilar from comparable national data. The injuries to all the fatally injured occupants are described in detail using the AIS (Abbreviated Injury Scale) and ISS (Injury Severity Score) procedures. These injuries are then related to their most common sources, for specific crash configurations. Fifty percent of the fatal impacts involved collisions with either fixed objects or other vehicles with masses at least five times that of the case vehicle. The vehicle deformation is described in terms of the frequency and severity of various collision types. The distribution of impact types was as follows: frontal, 55%; side, 27%; roll, 10%; rear, 1%. No single equivalent test represented the majority of frontal accidents which resulted in at least one fatally injured occupant, but the most frequently occurring classifiable frontal equivalent test was the 1/4 overlap. In 48% of assessable frontal impacts, the Equivalent Test Speed (ETS) was below 50 km/h, and in 46% of cases where a deltaV (speed variation) value was calculated, deltaV lay below 50 km/h. It was shown that ETS distribution contained greater proportions of severe frontal impacts than were observed in a representative study of all injury level police reported accidents. In frontal impacts, drivers received more AIS 5 and 6 abdominal injuries than rear seat passengers, but fewer AIS 5 and 6 head and neck injuries. Over 60% of life threatening head and neck injuries in frontal impacts resulted from contacts outside the passenger compartment. Over 70% of AIS 5 and 6 driver chest and abdominal injuries resulted from steering system contact in frontal impacts. The fascia accounted for 45.5% of front seat passenger AIS 5 and 6 chest injuries, and 58.3% of similar grade abdominal injuries. In side impacts, occupants on the struck side received life threatening head and neck injuries from contacts outside the passenger compartment in over 60% of the cases; principal sources of chest and abdominal injuries were the side structures of their own cars. Similar patterns of chest injury sources were observed for occupants sitting on the nonstruck side. Injuries and deformation are reviewed in the light of existing and proposed safety legislation in Europe. The effect of compulsory seat belt use on this sample is estimated, and the effects of other safety

standards and their relative priorities are discussed. It was judged that 100% usage of front lap/diagonal belts could potentially have saved 40.6% of the front seat occupants. The use of three-point belts in all rear seating positions could have saved 73.7% of the fatally injured rear occupants and a further 6.1% of front seat occupants. It is estimated that the next greatest reduction in fatalities could be achieved by improving passenger compartment integrity and reducing under-run hazards associated with impacts between cars and heavy vehicles. In terms of car design alone, improvements in the steering wheel and column system are likely to produce the greatest savings. The increased importance of side impacts and under-runs and an increased level of intrusion in comparison with the current accident experience are noted.

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HS-020 146

BUMPER CHARACTERISTICS FOR IMPROVED PEDESTRIAN SAFETY

An investigation is described in which the effects of bumper height, bumper position relative to the vehicle front end, and bumper design on the forces and bending moments generated in the legs of free-standing adult and child pedestrian dummies were determined. Studies of real-life accident data have revealed that the most frequent injury received by a pedestrian in collision with a car is a fractured or broken leg, mainly the result of impact with the bumper. Research work was carried out on a pedestrian/car collision rig which enabled impact tests to be performed under controlled velocity and braking conditions. Foot/ground friction was found to be important in the generation of forces in the leg and subsequent kinematics of the pedestrian; elimination of friction reduced leg loads by up to 50%. Test results have shown that the bumper forces and leg bending moments rise with increasing bumper height. Over the practical range of bumper heights, the maximum bending moment in the leg coincided with the height of the bumper. High bumpers (approx. 20 in) generated intolerably large bending moments in the adult knee whereas a bumper height of 10 in. reduced this to virtually zero. Striking the leg at the center of percussion (approx. 12 and 1/2 in. off the ground for adults) generated negligible forces in the hip, but large values could still result from direct contact with the vehicle front and the ground. Suitable bumper heights to improve pedestrian safety, taking into account the practicality of using very low bumpers, would be 12-14 in. The effect of bumper lead (the amount the bumper projects forward of the front end structure) cannot be considered in isolation. Bumper lead should mainly be considered as a measure of reducing front end contact loads, typically 5 in. dependent on the front and height. A two-dimensional theoretical model, which determined the bending moment distribution along the leg, gave good correlation with experimental results and enabled maximum bending moments to be predicted to within 8%. Utilizing the experimental and theoretical information, means of reducing forces in the legs to acceptable levels in 15 mph impacts have been investigated. load deflection characteristics and the ability to raise the slightly thereby reducing foot friction.

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HS-020 147

FULL-SCALE EXPERIMENTAL SIMULATION OF PEDESTRIAN-VEHICLE IMPACTS

A series of ten full-scale experimental simulations of ped an-vehicle impact was carried out using cadavers and a percentile anthropomorphic dummy. The test subjects impacted laterally and frontally at 24, 32, and 40 km/h (1 and 24 mph). Each subject was extensively instrumented miniature accelerometers, up to a maximum of 53 transdu The nine-accelerometer scheme was used to measure ar acceleration of body segments from which it was possil compute the Head Injury Criterion (HIC) for cadaver hea pact. A full-size Chevrolet was used as the impacting ve The impact event was three-dimensional in nature which the body segments executed complex motions. In ticular, the tendency for the subject to rotate onto its was observed in both the dummy and the cadaver. Dumm pacts were more repeatable than cadaver impacts, bu response of each test subject to almost identical impact quite different. The height of the subjects determined th of head-hood contact, and the impact velocity determin violence of motion on the vehicle hood. A padded fro appeared to lower linear acceleration but not angular ac tion of the impact leg. Based on the HIC, head-hood con apparently more severe than head-ground contact. S fractures occurred in every cadaveric experiment. How large number of screw holes were made for the attachm accelerometers; and, in many cases, it was not possi ascertain the exact cause of the fracture. The acquire could be used to validate existing gross motion sim which are capable of simulating pedestrian-vehicle impac

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HS-020 148

BIOMECHANICS OF REAL CHILD PEDESTRI ACCIDENTS

Based on thorough medical and technical investigation real pedestrian accidents, including 128 accidents i children, the influence of various parameters of vehi traffic participants on kinematics, injury mechanist traumatizing of pedestrians are outlined. The main ef in the analysis of the largest main-group, the child ped

15 years of age, below 9.5 m/s. For children younger than six years of age, an average collision speed of 11.3 m/s was established, compared to one of 9.1 m/s for older children. It was found that children most frequently suffered an impact to their sides. The highest frequency of primary head impact with the vehicle front was established within 30% and 50% of the vehicle width, measured in walking direction. The most severe primary head injuries resulted, for the pontoon contours, from the impact point of the pelvis at the edge region of the vehicle front, and for V-contours in the region 0% to 10%, and 50% to 70% at the vehicle front, measured in running direction. The throw-on distance to the vehicle is, with V-contours, greater than with pontoon contours, and is primarily dependent on body size, height of front edge of hood, the bumper height, and collision speed of the vehicle. The throw-off distance with pontoon contours was 20% greater for children than adults, larger with pontoon contours than with V-contours, followed by box contours. Up to the average impact speeds, pontoon contours caused the largest mean OAIS (Overall Abbreviated Injury Scale)-values to child pedestrians, with a pronounced disadvantage to younger children; beyond this speed, the box contour caused a larger one. The primary injury severity for all contour types in all severity degrees was found, on average, at lower impact speeds than the secondary injury severity. The largest Relative Traumatize Degree (RTD) occurred with child pedestrians for all contour types to the head, followed by injuries of the thigh with pontoon contours, and the shank with V-contours. Child pedestrians up to the age of six are more endangered than older children and receive the highest RTD to the head (including skull-brain trauma), followed by injuries of the lower extremities and of the abdominal region. The most frequent cause of injuries to the head are the first half of the hood with the pontoon contour, the second half of the hood with the V-contour, and the radiator region with the box contour. After the box contours, second place in aggressiveness to child pedestrians are the exterior parts of the pontoon contours in the following order: front end of hood, bumper, and first half of hood. The optimal height of the bumper for child pedestrians seems to be 25.4 cm. Fifty percent of the impact speeds of vehicles with pontoon contours in which child pedestrians suffered a primary AIS 2 of a single body region lie below 8.8 m/s for the lower extremities, and, for the head, below 8.7 m/s.

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HS-020 149

COMPARISON BETWEEN CHILD CADAVERS AND CHILD DUMMY BY USING CHILD RESTRAINT SYSTEMS IN SIMULATED COLLISIONS

A comparison was made between child cadavers and child dummies equipped with child restraint systems in simulated collisions. Until now only impact tests using dummies and animals had been conducted. In this study, frontal impact tests were conducted using a restraint system consisting of a deformable safety impact table combined with a lap belt. Two dummies and four cadavers of children aged two, six (two cadavers), and eleven with body weight of 16 up to 31 kg were used on a deceleration sled track with impact velocities of 30 km/h and 40 km/h at a medium deceleration of 20g. None of the test subjects showed injuries to the inner organs; however, numerous muscular hemorrhages as well as hemorrhages of discs and ligaments were noticed. The HIC (Head Injury Criterion) values lay between 100 and 500; accelerations in the x-direction up to 44g and in z-direction up to 85g occurred at the head. Lap-belt forces of 160 up to 400daN were measured. A weak point of the restraint system is shown in the fact that the child's movements are considerably limited, a factor also noticed in other child systems; however, the protective function proved to be an advantage. The movements during the impact, pictured by high-speed cameras, essentially differ from those of adults wearing 3-point belts. The maximum flexion of the vertebral column is, due to the system, located in the transition of the thoracic to the lumbar vertebral column; the flexion angles amounted to about 90°. As expected, the maximum head displacements in relation to a sled-fixed axis were dependent on the impact velocity and the body height, and ranged between 50 cm (crash velocity 30 km/h, body height 97 cm) and 90 cm (crash velocity 40 km/h, body height 139 cm). Results show that the child cadaver and child dummy kinematics are similar during the frontal impact. Also, the belt load history as well as the course of the resultant head decelerations correspond to a great extent. Despite a lower dummy weight, higher force maxima were measured than in the cadaver. Significant differences were observed in the flexion behavior of the vertebral column. It is concluded that the dummy is suited for preliminary examinations of child safety devices; however, child cadaver tests are indispensable for the investigation of the tolerance limit. It is emphasized that the semi-cylindrical shaped safety table causes a lower compressive load on the abdominal region and thus protects the inner organs.

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HS-020 150

THE SAFE DECELERATION OF INFANTS IN CAR CRASHES

The most important biomechanical characteristics of the head, neck and shoulders of infants from birth to about six months are compiled in view of the development of adequate restraining devices for this group. The conventional engineering approaches (protection for range of accidents with greatest frequency, convenience for parent and infant, simplicity of correct use, ballistics of restraints) are briefly discussed. The major part of the discussion is about a new infant car bed, a swinging bed. The long axis of the shell of this bed is placed perpendicular to the main axis of the vehicle on the rear seat. The top of the shell is attached at both sides by a strap to the vehicle frame, for example by the adult belt. As the center of gravity of the shell plus infant is below the attachment points, the shell turns in a frontal crash and stops in a 90° position. This transfers the impact load over a large area of the infant and also reduces the duration of maximal impact for each area elements. The new infant car bed has taken into account that infants up to 8.5 kg of weight cannot sit and must lie down when transported in cars. Head and torso decelerate simultaneously and gradually, with a minimum of strain on the

neck, on a large, shifting area, thus reducing the severity of the deceleration. Ejection of the child is positively prevented by a sleeping bag, which restrains the infant in the shell. No netting on top of the shell is necessary. The desired test performance can be demonstrated in dynamic tests under different test conditions. To extend its usability the infant car bed can be fitted into a complete baby carriage system and be equipped with an optional carry cot. The development from the first models for production is discussed, and results of sled tests using dummies are given.

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Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p543-81
Rept. No. SAE-760816; 1976; 39refs
Availability: In HS-020 133

HS-020 151

COMPARATIVE KNEE IMPACT RESPONSE OF PART 572 DUMMY AND CADAVER SUBJECTS

A comparison of whole body, target impingement knee impact response for a Part 572 dummy versus that for anthropometrically similar embalmed human cadavers is presented. Response is defined here to include the impact force-time history as sensed by femur load cells, and impingement target load cells for the dummy and by the target load cells for the cadavers. A knee impact response test was performed in which the sled borne, unrestrained surrogates were arrested by impingement?against load measuring contact targets for the knees, chest and head. For the padded, rigid targets used, the dummy knee contact forces exceeded those for anthropometrically matched (stature and mass) cadavers by 30% at approximately 4 m/s and by 100% at approximately 7 m/s. Pulse durations were correspondingly shorter for the dummy. Also, for the dummy, the ratio of femur force to target impingement force was approximately .8. These results from whole body target impingement testing of dummy and matched cadaver subjects, are in agreement with the findings of Horsch from hard surface pendulum knee impacts against stationary surrogates and isolated leg structures. Both studies have disclosed a significant difference in knee impact response for the Part 572 dummy and cadaver subjects for contact surfaces of high to intermediate hardness.

by Charles K. Kroell; Dennis C. Schneider; Alan A. Nahum
General Motors Corp., Res. Labs., Warren, Mich. 48090; University of California, Univ. Hospital, Dept. of Surgery, San Diego, Calif.
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p583-606
Rept. No. SAE-760817; 1976; 8refs
Availability: In HS-020 133

HS-020 152

STATIC AND DYNAMIC ARTICULAR FACET LOADS 0EXISED SPINAL SEGMENTS0

An investigation of the magnitude of the facet load during static and dynamic loading of an exised spinal segment was made. The applied loads resulted in a close simulation of those ing machine. During these tests, both the total spine load an the intervertebral load were measured: and thus, the facet loa was determined without relying on any assumptions. Result from tests on five different cadaveric spinal segments, involv ing 32 static runs and 62 dynamic runs, show that facet loa exist under both static and dynamic loading and that the joints are capable of carrying up to 40% of the total spir load. The unloading phenomenon which was reported b Prasad et al was observed in two groups of tests, with o group only showing tensile facet loads of a magnitude in t range of 10% of the total load. More tests are needed to i vestigate the significance of this phenomenon.

by N. S. Hakim; A. I. King
Wayne State Univ., Detroit, Mich.
Grant NIH-GM20201-03; NIH Career Development Award 5-K04-GM21145-05
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p607-39
Rept. No. SAE-760819; 1976; 15refs?
Availability: In HS-020 133

HS-020 153

A PROCEDURE FOR ESTIMATING INJURY TOLERANCE LEVELS FOR CAR OCCUPANTS

A method for estimating the levels and range of human inj tolerance for car occupants by correlating injury informat obtained in accident investigations with laboratory tests sh lating the accident conditions using an anthropomorp dummy is described. The injuries are those sustained by oc pants restrained by safety belts when subjected to imp loadings in road accidents. The principle of the technique i reconstruct accidents in which injury data are known, u the OPAT (Occupant Protect?0? Assessment Test) dummy which will be the basis of measurement in imp tests. The injuries received in the accidents are then correl with the forces measured on the dummy. In this way the i ry tolerance limits for living subjects are obtained directl terms of reading from the test dummy. The limits are necessarily the forces which would act on a human in an cident but are the forces which the test device would mea in circumstances where the human tolerance level is reac These are the measurements finally required in an impact procedure for regulatory or design purposes. It is shown this technique enables the estimation of the proportion of population likely to be injured at any specified value of a injury-related impact parameter. Suggested tolerance cri tehiviele fractures, shoulder belt tension at upper anchor rib or sternum fracture, shoulder belt tension at u anchorage and spine deceleration, exceeded for three ms dominal injury, lap belt remaining on pelvis; brain i without head contact. HIC (Head Injury Criterion); all belt injuries; (sum of seat belt tensions) are given using technique based on the injury data presently available. It tended to develop this method further to include other are injury and to refine the levels already estimated as more i and test data become available.

by R. W. Lowne; J. G. Wall
Department of the Environment, Transport and Rd. Res. L London, England
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conferer (20th) Proceedings," Warrendale, Pa., 1976 p641-64

PELVIC ORIENTATIONS OF THE TED VOLUNTEER

raphic study of two volunteers in a vehicle ition was performed to gain insights into the ital geometry associated with this posture. A iensional analysis of each radiogram was util- antitative results. Quantitative descriptions of nfigurations have not been available; and, ae- has not been a suitable biomechanical basis s portion of an anthropomorphic dummy niques utilized in the study proved to be prac- ng the lower torso skeletal geometry of the olunteer. It was found that sufficient resolu- pelvic radiogram, to enable definition of the nd femoral axes, requires careful control of ons. For the particular typical seated configu- this program, the volunteers' lumbar spine found to be nearly straight lines. Accurate can be obtained from X-ray radiograms, in rent parallax problem, if the set-up geometry mented and proper geometrical principles are ing the raw data scaled from the film. It is at skeletal geometric information of the type should be developed for a representative volunteers seated in a representative cross- le seats to evaluate the lower torso skeletal a statistical basis. Such a study should in- nation of the thorax-to-pelvis orientation in data compatible with the lower torso bending f SAE J826a (SAE Standard, SAE Handbook, lpitation techniques should be considered for X-ray radiography for studies of the nature of erein. The X-ray radiation hazard would be the volunteer's posture could be studied the need for fabrication of custom wooden of the pelvic triangle by palpitation proved to e SAE study referenced above.

equist; Lawrence M. Patrick
Corp., Environmental Activities Staff, Detroit,
tate Univ., Biomechanics Res. Center, Detroit.

3 (SAE-P-66), "Stapp Car Crash Conference gs," Warrendale, Pa., 1976 p665-96
760821; 1976; 2refs
HS-020 133

TION OF THORACIC IMPACT

rative test program on injury resulting from the thorax is presented. Injuries sustained by oracic and upper abdominal regions are second uries in terms of cause of death to motor vehi- mpact response was measured using cadaver bjects, and analytical functions relating to ic response to injuries observed in the experi- mpiled. Performance specifications are defined onse fidelity between human and surrogate periments, which varied G-level, velocity, and act, utilized restraint systems including belts, A-columns. Resulting injuries were recorded at S (Abbreviated Injury Scale) ratings were as- signed. Using the kinematic accelerometer data, injury-predictive functions were generated using statistical regression procedures. Results showed that human cadaver injury consisted of a predominance of fractures while baboon injuries emphasized contusions and lacerations to the underlying organs, probably the result of greater compliance of the baboon thoracic skeleton. Injuries observed in living subjects are less severe than those observed in cadaver subjects tested under the same conditions. Kinematic (accelerometer) instrumentation of the thorax yielded data which can be used to generate analytical functions which predict injury surprisingly well taking into consideration the small test sample available. The kinematic instrumentation package which has been developed could be applied to a surrogate thorax. If results using the surrogate can be correlated with actual subject test data, then additional surrogate test results could be used to predict an AIS injury number using injury-predictive functions.

by D. Hurley Robbins; J. W. Melvin; R. L. Stalnaker
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich.
Contract DOT-HS-4-00921
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p697-729
Rept. No. SAE-760822; 1976; 10refs
Availability: In HS-020 133

HS-020 156

THORACIC IMPACT RESPONSE OF LIVE PORCINE SUBJECTS

Experiments were conducted to assess the appropriateness of studying in vivo mechanical and physiological response to thoracic impact in a porcine animal model. A comparative anthropometry of the chest anatomy and structure of pig and man confirms this animal species as a suitable animal model for research studies into thoracic injury tolerances, impact responses and trauma-producing mechanisms. The thorax of the domestic pig (Sus scrofa) with average body weight of 57.6 kg (22% Lo), used in these studies is narrower (18% Lo), deeper (34% Hi), and smaller in circumference (14% Lo) than that of the average 50th percentile adult male human. The cardiovascular and respiratory systems of the domestic pig are a good parallel of similar structures in man. Vital organs in the pig were compared in weight to the average human's: heart (24% Lo), lungs (65% Lo), liver (11% Lo), kidneys (28% Hi) and spleen (33% Lo). The size, structure and function of these organs are similar to those of man. Five anesthetized pigs were exposed to blunt thoracic impact using a 21 kg mass with a flat contact surface traveling at 3.0 to 12.2 m/s. Time characteristics of the mechanical responses are similar between the animal model and fresh cadaver impact tests. Average peak mechanical resonse levels display large differences in sternal (73% Lo) and spinal (54% Hi) acceleration for similar peak applied loads (8% Hi) when compared with similar fresh cadaver tests. Maximum chest compression (1% Lo), tissue adjusted maximum normalized chest compression (3% Lo) and time of occurrence (3% Hi) are in excellent agreement between the animal model and fresh cadaver. The maximum normalized chest compression was less (22% Lo) in the animal model. The aortic blood overpressure peak is substantially lower in amplitude (67% Lo) than values reported for pressurized fresh cadavers subjected to similar impact conditions. Complete necropsy at the end of each test revealed transverse rib fractures, vascular hemorrhages in the apical lobes of the lungs and in the myocardium in all animals. Contusions of the liver surface were observed in several cases. The resultant injury

according to the AIS (Abbreviated Injury Scale) (20% Lo) is reduced in the live animal model as compared with the fresh cadaver. Rib fractures and lacerations are typical injuries observed in fresh cadaver impact tests.

by David C. Viano; Charles Y. Warner
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Brigham Young Univ., Provo, Utah
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p731-65
Rept. No. SAE-760823; 1976; 13refs
Availability: In HS-020 133

HS-020 157

A HIGH-SPEED CINERADIOGRAPHIC TECHNIQUE FOR BIOMECHANICAL IMPACT

A versatile, high-speed cineradiographic system has been developed for application to human injury and tolerance and vehicle occupant protection research. This system consists of a high-speed motion picture camera which views a two-in. diameter output phosphor of a high gain four-stage, magnetically focused image intensifier tube, gated on and off synchronously with shutter pulses from the motion picture camera. A fast lens optically couples the input photocathode of the image intensifier tube to X-ray images produced on a fluorescent screen by a d-c X-ray generator. The system is adaptable to a wide variety of experimental configurations. The screen size can be easily and inexpensively changed, and can be larger than the largest X-ray intensification tubes made. The image intensifier tube is readily switchable over a wide range of pulse repetition rates and pulse widths, allowing motion picture frame rates closely matched to dynamic events under study. The system is not limited to a particular X-ray generator, or type of radiation source. Potential improvement factors for optical efficiency exist at both the input and output of this system: resolution in this system is limited by film resolution as related to magnification ratios of screen to photocathode and output phosphor to film format size; as high-speed motion picture technology advances, these improvements can be incorporated. Examples of X-ray penetration of targeted human cadaver head, neck, knee, and lateral thorax views obtained with the system are shown and discussed. In summary, this high-speed cineradiographic technique is well suited for its intended applications because it is adaptable to service in a variety of biomechanics research programs, rather than a specific restrictive design for use in a single program.

by Max Bender; John W. Melvin; Richard L. Stalnaker
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich.
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conference (20th) Proceedings," Warrendale, Pa., 1976 p767-81
Rept. No. SAE-760824; 1976; 5refs
Availability: In HS-020 133

HS-020 158

AN EXPERIMENTAL MODEL FOR CLOSED HEAD IMPACT INJURY

The feasibility of using the unembalmed human cadaver as an experimental model for closed head impact injury was studied. Specifically, the investigation was conducted to determine whether pathological tissue changes seen in clinical head injury could be demonstrated in postmortem biologic material and could these changes be correlated with physical measurement of impact severity. A series of blunt head impacts was performed on stationary unembalmed human cadavers, th specimens prepared to simulate realistic fluid pressures withi the cerebrospinal fluid space and cerebral blood vessels Translational acceleration-time histories of the head wer recorded by biaxial accelerometers attached to the skull. Pea resultant head accelerations in excess of 3000 m/s squared an pulse durations of 5 m/s or less were observed in a series o ten experiments. The cerebral vascular system was perfuse with a carbon particle tracer solution. Following impact, can ful gross microscopic pathologic studies of the cranial soft ti sues were performed to assess vascular hemorrhage represented by extravasation of tracer solution into the brai Although the digital compuation period lasted 25 m/s, it w apparent from the data that the impact had essentially end at this time. With the exception of one experiment, the ma nitude of the applied impulse had reached a mean experime tal value of 76 and 93% of its final value at 5 m/s and 15 m/ respectively. Similarly, the mean of the Gadd Severity Ind (GSI) at 5 m/s and 15 m/s was 95 and 99%, respectively, of final value for all tests. Kinematic analysis of the high-spe motion picture film indicated that the impact to the fron bone resulted in initial translation followed by rearward ro tion and eventual hyperextension of the neck. Angular d placement of the skull 15 m/s after the onset of head accele tion ranged from 0.017 radian to 0.029 radian with a mean perimental value of 0.091. Since this angular displacement a linear function of time, the angular velocity was const resulting in zero rotational acceleration over the 15 m/s ti period. General conclusions drawn from this study are that sions of a type seen in clinical practice can be produced impacting an unembalmed human cadaver head: for type impact exposure of this study, biaxial acceleration time m surements can be made of the skull impact response wh describe its motion and characterize the impact severity: most severe impact exposure as determined by current h injury criteria HIC (Head Injury Criterion), GSI, (peak in force, peak resultant head acceleration) caused the great amount of intracranial trauma, and vice versa; and, finally larger experimental sample population is required to furt define the gradation of injury level and impact severity, provide information concerning the relationships between pact and observed pathologic changes.

by Alan M. Nahum; Randall W. Smith
University of California, Dept. of Surgery, San Diego, Cali
Publ: HS-020 133 (SAE-P-66), "Stapp Car Crash Conferenc (20th) Proceedings," Warrendale, Pa., 1976 p783-814
Rept. No. SAE-760825; 1976; 10refs
Availability: In HS-020 133

HS-020 159

SENSING SHAFT POSITION WITHOUT CONTACT

Useful measurement methods are compiled which are app ble to noncontact shaft position determination. Inductive p imity probes generate alternating magnetic flux fields from plied alternating current; they include both eddy current reluctance types. The former is most widely used for non tact shaft position measurement on rotating machinery. tenuation of the coil's field can occur by partial filling o probe/shaft gap with a conducting medium. It is typically in cost but is subject to high temperature error. Magr reluctance type probes are used when the gap may be with conductive material, there is a need for high signal at low carrier frequency, or for magnetic field deep per

tion into shaft. Noise can be reduced by a phase-sensitive detector. Capacitance probes are applicable to high temperature with precision; they are unaffected by magnetic fields, resistivity or permeability anomalies of the shaft material or by any transverse motion between probe and target. Optical reflected light probes use a fotonic sensor principle of operation. It is a flexible, small-diameter probe which is insensitive to magnetic fields, gives high resolution displacement measurements, and is intrinsically safe. Pneumatic sensors function by recognizing velocity and pressure changes upstream from a varying orifice. It requires a regulated air supply, and has a limited response unless it is integrated with a pressure transducer. Overall system calibration can be done by moving either the probe or the shaft itself.

by Rudolph Hohenberg
Mechanical Tech. Inc., Measurement Science Dept.
Rept. No. SAE-760313; 1976; 10p 7refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 160

COMPILATION OF DRAFT INFORMATION REPORTS, RECOMMENDED PRACTICES AND STATUS REPORTS PREPARED BY SAE ADVISORY COMMITTEE FOR THE DOT/SAE TRUCK AND BUS FUEL ECONOMY STUDY

Draft information reports on the general subject of measurement of fuel economy of trucks over 10,000 pounds and of buses have been prepared by ten SAE subcommittees of the SAE Advisory Committee for the DOT/SAE Truck and Bus Fuel Economy Study. The reports are the latest drafts to date and have not yet been verified by actual testing or been approved via the SAE consensus process. The report of the Driving Cycles Subcommittee includes sample images of driving cycles for local hauls, urban hauls, and long hauls. The Original Equipment Manufacturer (OEM) Vehicle Test Procedure Subcommittee's draft document concerns a proposed SAE recommended practice on a truck and bus fuel economy measurement procedure. The draft documents of the In-Service Test Procedure Subcommittee are proposed SAE recommended practices for in-service vehicle testing and for fuel recording. The Vehicle Correlation and Simulation Subcommittee presents a preliminary report. The Vehicle Categorization Subcommittee's draft document is a proposed SAE recommended practice on a medium duty and heavy duty truck and bus categorization system. The Basic Engine Modifications Subcommittee's proposed SAE recommended practice concerns a procedure for measuring basic highway vehicle engine performance and fuel consumption of both spark ignition and diesel engines. The draft documents of the Fans and Accessories Subcommittee are proposed SAE recommended practices for test methods of measuring power consumption of engine accessories for trucks and buses, and concerning information relating to duty cycles and average power requirements of truck and bus engine accessories. The Aerodynamics Subcommittee presents its chairman's status reports and a proposed information report on fuel economy measurement--truck and bus aerodynamic improvement devices. In addition, the Subcommittee presents a proposed recommended practice on fuel economy measurement tests for the evaluation of truck and bus aerodynamic improvement devices. The draft documents of the Rolling Resistance Subcommittee are a proposed SAE recommended practice for rolling resistance measurement for passenger, truck, and bus tires, and a proposed SAE information report on rolling resistance of pneumatic tires. The Driveline Components and Modifications Subcommittee presents its revised conference report, and proposed SAE recommended practices concerning a passenger car and truck automatic transmission test code and a power take-off test code. In addition, each Subcommittee section includes a historical synopsis of document development, a list of its official meetings, and a list of its members. Recommended future action includes finalization of the draft documents in conjunction with the SAE Standing Technical Committees, document verification according to the flowchart given, and preparation of expanded proposals from each subcommittee. Of the 25 tasks of the effort, the Advisory Committee has proceeded to tasks 5 and 6, and is working on tasks 7, 8, 9, and 11.

Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142
Rept. No. P-59A; DOT/TSC-1007; 1976; 337p
Cover title: "DOT/SAE Truck and Bus Fuel Economy Measurement Study Report." Work performed subsequent to DOT/SAE Truck and Bus Fuel Economy Measurement Conference, 21-23 Apr 1975, Ann Arbor (see Rept. P-59).
Availability: SAE

HS-020 161

FACTORS INFLUENCING THE DESIGN OF PASSENGER CAR SEAT BELT RESTRAINT SYSTEMS

The design engineer of passenger vehicle restraint systems has to consider functional performance, comfort and convenience, manufacturing feasibility, and cost/benefit analyses. Functional performance objectives include ability to restrain, conformance to governmental standards, fitting of as broad a range of body types as possible, and reliability and durability. Both existing and proposed regulations influence belt restraint design, for example the specification in FMVSS 208 limiting the distance between the centerline of a seated occupant and the intersection point of the lap belt and shoulder belt to a minimum of six inches. This well-intended regulation in fact forces a safety trade-off in the form of reduced user convenience. Another example is a regulation concerning pull strength tests for seat belts and anchorages: a recently designed Ford system involving shoulder belt anchorage to the seat back instead of to the roof or B pillar was not put into production because conformance to the regulations would have made it too heavy and too costly. As for methodology to improve voluntary seatbelt usage, Congressional rejection of the ignition interlock system in favor of the four-second to eight-second light/buzzer reminder system is seen as a step backwards. Statistical data indicate that the more obvious the reminder system the greater the rate of usage.

by Michael C. Webb
Ford Motor Co.
1976; 14p
Presented at Motor Vehicle Safety Seminar, Washington, D.C., Jul 12-14, 1976.
Availability: Reference copy only

HS-020 162

REMARKS BEFORE THE NATIONAL MOTOR VEHICLE SAFETY ADVISORY COUNCIL, MOTOR

VEHICLE SAFETY SEMINAR, DEPARTMENT OF TRANSPORTATION, JULY 14, 1976

The public policy principles of motor vehicle safety from the point of view of Secretary Coleman of the Department of Transportation are reflected in his National Transportation Policy Statement. Decisionmaking should be a comprehensive process involving a broad data base of such information as public opinion, economic and social impacts, and energy and environmental concerns as well as the primary safety objective. There is a regulatory reform initiative underway intended to reduce excessive Federal intervention which stifles the competitive market system. Unresolved issues of Federal action in safety regulation include the lack of much literature on the subject and the imprecise boundaries of authority under which the Federal safety activities take place. The public interest has been demonstrated to include factors other than safety consciousness, specifically concern for individual freedom of choice in using safety equipment in private transportation systems. All proposed safety regulations are reviewed against a threefold standard of their effectiveness in preventing accidents or improving accident survivability, their cost and who will pay it, and the question of individual liberties, with the Secretary tending to be in favor of allowing individual choice in the use of safety equipment when such choice does not endanger others.

by Judith F. Connor
1976; 10p
Presented at Motor Vehicle Safety Seminar, Washington, D.C., Jul 12-14, 1976.
Availability: Reference copy only

HS-020 163

AN ARRAY OF SOCIAL VALUES FOR USE IN ANALYZING THE NEED FOR SAFETY REGULATION

An analytical tool for assessing societal values relative to any type of safety standard is presented. It is a schedule of the following public concerns, on the basis of each of which the degree of favoring or disfavoring the measure under consideration is recorded. Public appreciation of the economic need for safety includes consideration of the size of loss preventable, effectiveness in preventing loss relative to costs, its benefit/cost status and priority, the absolute cost of the prevention measure, and the importance of it in the economy. The issues involved in the public image and psychological motives for safety are the need of the activity to demonstrate cooperation in public safety, the presence of the public's apprehension of the activity, the concern of individuals for the safety of a loved one, and the concern that a feasible study measure is being withheld. Public reaction to equality of treatment for various groups at risk includes the factors of the degree to which risk or loss is borne by one subject group for the benefit of others, the status of a subject group in benefitting from the safety-funded effort, and a change in the responsibility required of a subject group. Public concern for prevention of unfairness to a particular group in avoiding risk involves the ability of persons at risk to know the hazard in order to avoid it, and the voluntary or involuntary status of the persons at risk. Public concern for the status of groups as deserving protection involves status by reason of traditional special consideration such as for children, the aged, or the handicapped. Concern for the technical possibility of safety improvement involves assessment of the technical feasibility of improvement, the critical or uncritical role of improvement in safety control of the system, and the criticality of the timing of the action. Steps in properly using the array are the following. Define exactly the subject of the proposal being evaluated. Grade each concern from the administrator's point of view. Identify areas in which new data are needed to permit an assessment. Have the subject graded for each concern from the viewpoint of each interest, and the differences revealed. Carefully analyze areas in each schedule in which there are strong conflicts of values, considering also the overall pattern of such conflicts. Study the patterns of concerns served and agreements and disagreement of interests from the viewpoint of patterns of probable support or disapproval, and then study changes that would be desirable. Finally, decide whether to proceed with the proposed action, to drop it, or to modify it. Use of the array offers assurance that major concerns of society which could influence standards are detected and considered, and permits different attitudes of interest groups to be compared and studied. In addition, it sharpens judgment of the administrator by facilitating a balance of values in close relationship to interest groups, and serves as a checklist in which changes to strengthen the proposal or to broaden its support can be studied and planned.

by Henry H. Wakeland
National Transportation Safety Board, Bureau of Surface Transportation Safety
1976; 27p
Presented at Motor Vehicle Safety Seminar, Washington, D.C., Jul 12-14, 1976. Condensed from a presentation at Fourth International Congress on Automotive Safety, San Francisco, 14-16 Jul 1975. For complete version see the Proceedings, p875-905. Winner of the Edward J. Speno Award
Availability: Reference copy only

HS-020 164

SWEDISH GOVERNMENT AND INDUSTRY STUDIE OF BELT USAGE LAW EFFECTIVENESS. ABSTRACT

by Lars-Einar Nilsson
Saab-Scania A.B., S-V61 01, Trollhattan, Sweden
1976?; 11p
Presented at Motor Vehicle Safety Seminar, Washington, D.C., Jul 12-14, 1976. For abstract, see HS-020 165.
Availability: Reference copy only

HS-020 165

SWEDISH GOVERNMENT AND INDUSTRY STUDIE OF BELT USAGE LAW EFFECTIVENESS

In 1969, a standard became effective which required insta tion of three-point seat belts for front seat occupants in new passenger cars. Model year 1974 autos were required have emergency locking automatic seat belts for front se and in 1975, the requirement was extended to include rear s belts. Seat belt usage rates were rather low, and in 1971, Swedish Road Safety Office began campaigns to prom usage. Five such campaigns were completed between 1971 1974, with resultant average usage rates increasing from 15 to 35.6%. The increase was probably attributable to the c paigns and partly to the increasing number of seat equipped cars on the road. Between Apr and May 1972, a den increase in usage was noted which was probably du the lottery-like, "Bingo Week" campaign carried out du

age rates continued to increase gradually after
Swedish Road Safety Office statistics indicate
rose from 36% in Oct 1974 to 80-85% in May
introduction of the mandatory seat belt usage
ab research showed an increase in usage in
48% in 1974 to 93% in 1975. The first national
ed on the effects of the mandatory usage
re released by the Road Safety Office for the
of 1975, and the results, based on all accidents
police, showed a reduction in injuries of only
ade by G. Voigt of all fatal car accidents from
1975 show that of 223 car occupants killed dur-
months of 1975, 141 were not using their seat
Saab-Scania undertook research into road ac-
d to the three most recent model years of the
accidents in which the cars sustained serious
ch revealed that the steering assembly was the
ost frequently impacted by occupants. In the
lted occupants, none of the injuries sustained
n abbreviated injury scale (AIS) of two
e instrument panel caused the next largest
ies, though only six were serious. It was found
usage of seat belts significantly reduces the
ious injuries, though minor injuries may be
the seat belt itself. A graph is presented which
y rates of 219 unbelted and 393 belted Saab 99
rall injury reduction of 31% and a reduction in
of 53% is shown when seat belts were worn.
made for all car occupants (487 unbelted and
shows substantial overall injury reduction for
An injury distribution comparison shows that
ts receive fewer head injuries than unbelted oc-
belted occupants receive more, though less
s to the spinal column and torso. Injury dis-
ollected at 16 hospitals during 1974 and 1975 by
ssoc. for Traffic Medicine agree well with that
aab and are presented in table form. A com-
tic and emergency locking seat belts (table
ws that the overall protection from belts with
king retractors is somewhat better than from

Nilsson
B., S-461 01, Trollhattan, Sweden

otor Vehicle Safety Seminar, Washington,
, 1976.
ference copy only

DEATHS AND INJURIES IN CRASHES HEAVY TRUCKS: TEN STRATEGIES.

to the high accident and fatality rates of heavy
tegies are offered as countermeasures. They are
imizing the damage from the dissipation of
in a crash. First, prevent the initial generation
energy, such as by choosing safer modes of
possible. Second, reduce the amount of energy
reducing the weight of a given shipment by
goods closer to their destination and reducing
Third, prevent the damaging release of energy
ard accident prevention measures as highway
rovements, in particular in truck length and
uverability factors. Fourth, modify the rate or
spatial distribution of the release of the kinetic energy such as by use of seat belts. Fifth, separate the kinetic energy being released and the hazardous materials being shipped from the people or structures likely to be damaged. Sixth, use material barriers such as protective cabs and guardrail designs to attenuate the decelerative energy transfer. Seventh, modify the surfaces and basic structures likely to be impacted, particularly truck trailer sides which can usually be underridden by automobiles. Eighth, increase resistance to damage, especially to that of posterash fires. Ninth, move rapidly to detect damage and to counter its continuation and extension. Tenth, repair the damage and rehabilitate the injured; specifically, the trucking industry should bear its share of the costs associated with such damage.

by Susan P. Baker
Johns Hopkins School of Public Health, Baltimore, Md.
1976; 12p 11refs
To be presented at Motor Vehicle Safety Seminar, Washington, D.C., Jul 12-14, 1976. Supported by Insurance Inst. for Hwy. Safety.
Availability: Reference copy only

HS-020 167

INDUCEMENTS TO INCREASED SAFETY BELT USAGE

Before intelligent decisions can be made concerning ways to increase seat belt usage, or about substituting an alternative restraint system, it is important to update the seat belt usage data base to reflect information such as the ways in which comfort and convenience affect usage rates, the effectiveness of three-point belts and inertia reels, and information on usage rates by age of car or by specific seat belt system characteristics. Past studies were designed to obtain gross usage rates which did not yield information which would help answer questions about seat belt users. This sort of information is necessary to design new systems to ensure maximum usage, and to understand demographic and regional differences in order that educational and legislative campaigns can be focused and conducted more effectively. A systematic analysis of the differences in pre-law usage rates, educational campaigns, methods of enforcement, responses of insurance companies, and attitudes of courts which are to be found in the 18 jurisdictions which have implemented mandatory seat belt usage laws could be useful to the Department of Transportation (DOT) and the industry in increasing usage. Another opportunity for the generation of experimental data is the use of fleet vehicles with modified equipment and carefully monitored usage rates. DOT could expand its current program along these lines, using its authority to authorize exemptions to permit testing of experimental belt systems. The implementation of an intensive multi-media public education campaign in one or two target cities is another opportunity for experimentation. Television and motion pictures could provide their viewers with a constant reminder to use belts, if actors were consistent in their use. DOT has an opportunity to take the lead in recommending guidelines to the National Assoc. of Broadcasters and the Motion Picture Assoc. of America. The obvious objective of restraint system standards is to save lives and to reduce injuries, therefore, a seat belt which will be worn more often because it is more convenient and comfortable should be given serious consideration even though it may fail some of the standard's design specifications. Most existing and proposed seat belt legislation concentrates on adults; in fact, children are specifically excluded in many cases. It is suggested that mandatory usage for children only would be a

good place to start since it would be far easier for the public to accept. Such legislation would probably have to specify a minimum age in order to avoid legislating infant restraint systems and would probably need to designate an adult (presumably the driver) as the one legally responsible for belt usage by children in his vehicle. A report is appended on the Ford Motor Company's demonstration to NHTSA of a continuous-loop belt system incorporating a "window shade" tension reliever which was denied approval.

by Richard H. Shackson
Ford Motor Co.
1976; 6p
Presented at Motor Vehicle Safety Seminar, Washington, D.C., Jul 12-14, 1976.
Availability: Reference copy only

HS-020 168

KEY ISSUES IN HEAVY TRUCK SAFETY

A discussion (the major part of which is contained in appended form) of various aspects of highway safety with regard to heavy trucks is presented. Included are truck-tractor registration, discrepancies in various statistics on accidents involving trucks, the advantages of glider kits, and the need for increased appropriation of funds for the inspection of trucks. Also discussed are truck safety defects, comparative stopping distances of cars and trucks, jackknifing of tractor-trailers, number of fatalities in truck accidents compared to those involved in car and train accidents, and advantages of the cab over engine (COE) configuration. Federal Motor Vehicle Safety Standards are discussed, as are certain reports by the National Safety Transportation Board which have been criticized for not considering all aspects of accidents involving trucks, proposed Federal regulations with regard to truck operation, and a letter from the Federal Highway Administrator to the Chairman of the Subcommittee on Surface Transportation of the House of Representatives discussing the need for improvement in the Bureau of Motor Carrier Safety (BMCS) data collection, analysis and presentation. The National Motor Vehicle Safety Advisory Council should realize the essential nature of truck transportation to the economy, the constant striving to improve truck operation on the highway, the lack of available data with which to evaluate safe operation of trucks on the highways, the necessity for complete cooperation by all those involved with the Federal Highway Administration, the need for additional staff for the BMCS in order for it to do an effective enforcement job, and the need for establishment of priorities by operators and regulatory agencies to solve highway safety problems.

by Robert H. Shertz
American Trucking Associations, Inc., Safety Comm. on Res. and Environment, Washington, D.C.
1976; 52p 9refs
Presented before the National Motor Vehicle Safety Advisory Council, Motor Vehicle Safety Seminar, Washington, D.C., 12 Jul 1976.
Availability: Reference copy only

HS-020 169

STATISTICS ON HEAVY TRUCK ACCIDENTS

Data and analyses that the National Highway Traffic Safety presentation of slides, along with tabular and graphical material. The high severity of large truck accidents plus higher involvement rates (on limited access roads) emphasizes safety as a key issue in large truck operations. The priority area is collisions with cars and other smaller vehicles. Accident severity appears to increase with truck weight, while accident likelihood appears to be related to vehicle size. These data should not be interpreted as a condemnation of large trucks but rather they should serve to better define the nature of large truck accidents, aid in development of countermeasures and indicate areas for further study and analysis. A report entitled "Injury Rate As a Function of Truck Weights in Car-Truck Accidents" by Thomas N. Herzog (DOT-HS-801 472, NHTSA-TN-N43-31-7) is presented which contains an analysis of the Bureau of Motor Carrier Safety (BMCS) data file of car-truck accidents for calendar years 1973 and 1974. Principal conclusions of this work state that the death rate for nontruck accidents increases with the weight of the truck, that there is no evidence to suggest that this fatality rate levels off at a loaded weight of 70,000-80,000 pounds, and that the fatality rate for nontruck occupants in car-light-truck accidents (i.e., those trucks whose loaded weight is no more than 20,000 pounds) is less than half that in car-heavy-truck accidents (i.e., those trucks whose loaded weight exceeds 20,000 pounds).

by Glenn G. Parsons
National Hwy. Traffic Safety Administration, Office of Statistics and Analysis, Washington, D.C. 20590
1976; 54p 2refs
Presented before the National Motor Vehicle Safety Advisory Council, Motor Vehicle Safety Seminar, Washington, D.C., 12 Jul 1976.
Availability: Reference copy only

HS-020 170

KEY ISSUES IN HEAVY TRUCK SAFETY

The most unfair and misleading comparison is made when "exposure" (miles driven by heavy trucks vs. automobiles) is not given proper treatment in accident studies. Mechanical defects of trucks in accident causation is discussed (an appendix contains tabulated data), figures demonstrating that tires and brakes lead the list as killers. One glaring problem is the failure of the Bureau of Motor Carrier Safety (BMCS) to promulgate a regulation requiring the carriers to maintain hardware required by the National Highway Traffic Safety Administration (NHTSA), e.g., requirement to equip trucks and trailers with 121 brakes. An increase in the BMCS field staff is necessary along with getting an adequate enforcement program going. Mechanical defects often contribute to accidents where they are not the proximate cause. Systematic inspection and preventive maintenance programs are shown to reduce accident rates on the highway. Better brakes are needed for trucks, and speed maintainability of trucks needs to be improved to reduce disparate speed differences between cars and trucks on upgrades. Uniform national weight and size limit commensurate with safety (specifically to omit the tractor from overall length limits) need to be established. Underride protection is needed and can be improved. Federal safety inspection needs to be beefed up, and truck crashworthiness needs to be improved by extending safety standards to trucks. An experimental safety vehicle program for trucks needs to be established. The Dept. of Transportation should review its scattered responsibilities and authorities regulating truck safety, special studies into truck handling should be ur

t. On the negative side, special truck lanes are

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rotherhood of Teamsters, Safety and Health
gton, D.C.

re the National Motor Vehicle Safety Advisory
r Vehicle Safety Seminar, Washington, D.C., 12

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RY POLICY; AN INDUSTRY'S VIEW OF NMENTAL PROCESS

hen the Interstate Commerce Commission (ICC) Congress has established some 82 regulatory rds, bureaus, and commissions, 14 of which ig in the last eight years. Some 74,000 regulators eir employ; and, in Fiscal 1976, the budgets of s totaled an estimated $2.9 billion. The growing leral regulations (10,000 pages of rules and regudded each year) raises serious concern about the f regulations on the economy. Added expenses ness as a result of costs incurred in following tions have to be recouped in the marketplace. It hat Government controls be imposed only when orces will not achieve the necessary objective ulations are cost/beneficial and cost/effective. ction of the environment and public safety are equire regulation. However, lack of accountabiliation in achieving publicly supported national blems inherent in the present regulatory system. lem which exists relates to regulation by statute ss has been too explicit in mandating specific s before a careful assessment of their needs was otor Vehicle Manufacturers Association (MVMA) ncern that there is an urgent need for a comview of the Federal regulatory system. A mitted to Congress regarding this matter the should include the following elements: an action anism (adoption of a timetable and framework), equate time to assure a thorough review of incy actions as well as interagency conflicts) ongoperiodic review of regulatory activity), cost t/benefit, cost/effective), and economic impact on inflation, employment and competition). upports the concept of zero-base budgeting. It is nded that regulatory agencies, such as the Naay Traffic Safety Administration (NHTSA) and nmental Protection Agency (EPA), adopt) assure greater outside consultation before a ce of rulemaking is issued. As early as possible, ould identify and communicate the nature of a blem and why regulation is deemed necessary. ctors associated with regulations should be asll as available alternatives. The MVMA and its) support, when possible or necessary, greater nong product standards imposed by different na-

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e Manufacturers Assoc. of the U.S., Inc.

ore the National Motor Vehicle Safety Advisory
or Vehicle Safety Seminar, Washington, D.C., 12

Reference copy only

HS-020 172

CONSUMER REACTION TO SEAT BELT COMFORT AND CONVENIENCE

Slides and the accompanying text which show the general chronology of seat belt system evolution, in terms of State and Federal requirements, are provided. Improvements in elements of seat belt systems include push-button buckles attached to partially-stiffened webbing support to keep buckle from sliding between seat cushions, latchplates easier to find, torso harness webbing less apt to ride against neck, and retractors for lap belt and torso harness portions of seat belts. Driver personality types include those who rebel against being told what to do, those who do not want to bother with a system requiring them to remember something, those who believe in safety, those who know that safety is important but wonder why it is so difficult to come by, and those who may or may not use seat belts from time to time. Poor design features of seat belts include seat belt anchoring that is determined by shape and structure of vehicle models, lap belts anchored to the floor, lap belt anchoring points behind the seat, low positioning of buckles, belt-sensitive retractors, arm rests and consoles located in areas which impede access to latchplate or buckle, nonstandardized buckles, single loop, single retractor concept in belt systems, and guide position not given best-fit consideration. Results of a survey of seat belt users in which questions were designed to elicit answers that were more design oriented are given in terms of problems concerning lap belts, shoulder harnesses and single belt, single retractor systems. Results of laboratory studies designed to determine the extent to which certain system elements (buckle configurations and release mechanisms, push button configuration, push button release force, belt retractor tension, retractor systems, and webbing geometry) are given. Two optimized, three-point belt systems based on results of these studies are described, and results of an evaluation of the optimum systems versus four other state-of-the-art systems are given. Comfort and convenience can be substantially improved from existing systems in late model cars, passive belt systems require further development. Detailed specifications for optimum system are available in NHTSA-HS-801 277.

by Wesley E. Woodson
Man Factors, Inc., San Diego, Calif.
1976; 46p 2refs
Presented before the National Motor Vehicle Safety Advisory Council, Motor Vehicle Safety Seminar, Washington, D.C., 12 Jul 1976.
Availability: Reference copy only

HS-020 173

POLITICS AND BENEFIT/COST ANALYSIS IN NHTSA RULEMAKING

An analyis of the National Traffic and Motor Vehicle Safety Act of 1966 in terms of language is presented. In short, what the Congress created for the Secretary of Transportation was a regulatory authority granting a wide range of discretion, in which the overriding consideration is safety. The initial Federal motor vehicle safety standards, 29 of which were issued from 1966 to 1969, raised relatively few cost questions. Two recent occurrences, however, have brought the question of benefit/cost analysis to the fore, and are central in Congressional reassessment of its appropriate role in the rulemaking of NHTSA and other Federal agencies. The first is the involvement of the Council on Wage and Price Stability in Federal ru-

emaking, particularly in NHTSA rulemaking where it has rged postponement or abandonment of proposed rules until economic analysis is performed showing that benefits exceed osts. The second source of current concern is a set of three o-called "regulatory reform" policies issued by Secretary of Transportation Coleman on Apr 13, 1976. The first policy equires an evaluation of the costs, benefits, and other impacts f all Dept. of Transportation rulemaking actions prior to their ssuance either in proposed or final form. The second policy equires that departmental elements such as NHTSA provide he Secretary with an information memorandum on regulations which are potentially costly or controversial at least 30 days rior to their proposed publication date. The third policy eflects the beginnings of a departmental process for evaluat- ng regulations already in place. Some preliminary observa- ions regarding the use of and problems associated with (e.g. lusive data, difficulty in making projections, credibility of ef- ort) benefit/cost analysis are outlined. Guidelines proposed or the NHTSA Administrator in applying benefit/cost analysis nclude the need to acknowledge the extreme limitations of the nalysis with respect to proposed rulemaking actions now and or the immediate future, the need to obtain as much cost data nd as refined a prediction of projected benefits (in terms of human injury and fatalities which can be avoided or reduced) efore a decision is made, the need to step up the effort to up- grade the state of the art of NHTSA benefit/cost analysis, the need to apply the advanced benefit/cost tool in assessing the mpact of existing standards not to the process of issuing new standards, and the need for the regulatory agency to recognize nd admit error. It seems advisable for the Secretary and NHTSA Administrator to continue to make regulatory deci- sions in the best judgment, without introducing a benefit/cost requirement. A bias should be exercised toward issuing new standards and upgrading existing ones which show promise in reducing fatalities and injuries.

by Lowell Dodge
Congress, House Com. on Interstate and Foreign Commerce, Subcom. on Oversight and Investigations, Washington, D.C.
1976; 9p
Presented before the National Motor Vehicle Safety Advisory Council, Seminar on Public Policy, Politics and Motor Vehicle Safety Standards, 14 Jul 1976.
Availability: Reference copy only

HS-020 174

CONGRESSIONAL ACTION TO REFORM FEDERAL REGULATION

Proposals to reform the Federal regulatory process fall into 11 basic categories. The first is one which calls for further study of the issue. The second calls for creating a Congressional body to provide Congress with the staff and technical facilities it needs to carry out its oversight function, and also to aid it in the consideration of reform plans. The third is to provide for a Congressional veto of agency regulations. The fourth would provide for the phasing out or elimination of certain agencies. The fifth calls for various organizational and administrative changes in the way the agencies operate. The sixth involves proposals for substantive reforms in specific areas, e.g. trucking, railroads, airlines and banking. The seventh is to require cost/benefit analyses for proposed regulations. The

tion and using the taxing authority or various charges or fines to pursue the goals for which the regulation was established. Of these proposals, those calling for arbitrary elimination of certain agencies, and those which provide for a Congressional veto of agency regulations are the worst. Many of the other approaches contain valuable ideas but cannot, alone, achieve the best results. It is thought that what is really needed is a procedural approach along the lines of Percy-Byrd or Administration bills, or some compromise of these two. Under these plans, a disciplined timetable for the consideration and possible implementation of reform plans would be established. This would allow any further study to be coupled with a concrete program for action. In addition, by requiring related agencies to be dealt with as a group, it will be possible to examine the Federal regulatory effort in a given area in its entirety. And, having a fixed timetable will allow the maximum coordination of effort by the President, Congress, the agencies, academics, interest and consumer groups and all other affected parties. Finally, suitable action-forcing measures can be designed to encourage these groups to work together for reform. In conjunction with this type of reform effort, Congress would probably have to increase its staff resources, and such analytical tools as cost/benefit analysis and zero-base budget review could be most profitably applied.

by Dan Levin
Congress, Senate Government Operations Com., Washington, D.C.
1976; 12p
Presented before (followed previous paper) the National Motor Vehicle Safety Advisory Council, Seminar on Public Policy, Politics and Motor Vehicle Safety Standards, 14 Jul 1976.
Availability: Reference copy only

HS-020 175

NEW DEVELOPMENTS IN SAFETY BELT DESIGN

With regard to donning seat belts, the three factors which directly determine comfort and convenience are the accessibility of the latch plate to the hand, the amount of force required to extract the stowed webbing to encircle the body, and the ease of engaging the latch plate with the buckle. The two retractor systems which are in the majority today are good with respect to the first two factors, but improvement in attaching the belt is needed. Improved systems have been developed in which buckles are semirigidly mounted in a position to receive the latch plate with a one-handed insertion. Buckles themselves are being improved with respect to insertion load, sensitivity to latch plate alignment and indication of when safe engagement has been achieved. Autolock type retractors in the lap belt, used in most two retractor systems, have now been designed to overcome the problem of inadvertant lockup. As far as single retractor systems go, in 4-door cars, the problem of difficult access to the latch has been overcome by the attachment of belts to the vehicle body so that latch place is within reasonable reach and the belt webbing can be withdrawn to buckling position with little difficulty. Improvements to make the latch more accessible in 2-door cars include roof-mounted retractors with seat-back mounted web guides or belts attached to the door. A passive restraint system with a door-mounted shoulder belt and dash-mounted knee pad offers an interesting approach to convenient operation. The obvious factors in considering the

esented an attempt to provide the occupant with
nual method of setting an individual comfort
e shoulder belt. A further development is the
Reliever, sometimes called the "Window Shade
unit is designed to provide the user with a
amount of belt slack on a semiautomatic basis.
unit has three disadvantages--possibility of in-
erous amount of belt slack, stowage prevention
unbuckled in the tension relieving mode, and
single retractor systems, slack in shoulder belt
.g to lap belt. A novel solution to these problems
Comfort Zone" which can be added to any form
or and provides two levels of retraction force
ensure good retraction and storage, low level
ught into operation automatically when the
tracted and allowed to retract a small amount).
ng the belt, the important factor is to return the
ractor to ensure protection of the belt when not
guarantee availability when needed. Two-retrac-
n cause difficulty because the shoulder and lap
compete with each other; and if the lap belt
retract into the autolock retractor, it cannot be
subsequent use, and a belt user will think the
s failed. The more sophisticated autolock retrac-
earlier is justified in this instance. With regard
rotection capability of belt systems, there are a
as where improvements can be made and these
ency locking retractor sensitivity, belt geometry,
energy absorbers, and belt tighteners.

Babbitt; Cyril Henderson
ty Equipment Corp.

ore the National Motor Vehicle Safety Advisory
r Vehicle Safety Seminar, Washington, D.C., 13

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S IN HEAVY TRUCK SAFETY

ergence of opinion with regard to key issues in
afety. Several basic reasons underlying the con-
ding this issue include the following. There is a
accident data gap due to government's failure to
mprehensive and credible motor vehicle accident
n system. The expert syndrome is based on
s about all vehicle accident experience from data
presents some quick analysis of a subset of na-
local data base, or a sample so small as to be of
significance. The definition problem concerns
s as every vehicle that is not an automobile or a
n defining trucks as those commercial vehicles
ing more than four tires on the pavement and
,000 GVW. Also, there should be groups within
hich may have such different hazard charac-
to single set of safety countermeasures will meet
safety. An examination of the Motor Carrier
ile, based on over 25,000 carrier-filed accident
tes that on the whole motor carrier accident ex-
proving, considering that the number of vehicles
that highways are not materially increasing, and
operation have dramatically increased, thus
emendous increase in commercial value risk ex-
ublic good is served by simply decrying the
nance of trucks because there is no substitute
acking, truck transportation is absolutely essen-
tial to the maintenance of our standard of living and way of life, and a zero accident position is not even remotely possible in a free society in which vehicles are operated by human beings. With regard to highway safety in trucking, brake improvement is an achievable and beneficial goal, improved speed maintainability is not a problem on the Interstate at the 55 mph limit, uniform national size and weight laws can only come about by Congressional or State by State actions, the Bureau of Motor Carrier Safety (BMCS) requirement for rear-end protection (underride guards) will be reviewed, the feasibility of special truck lanes on the highways is questionable, the extension of auto safety standards to trucks should only be approached on a case by case basis, an experimental safety vehicle program for trucks is endorsed, a BMCS study relating to tank semitrailer integrity in rollover accidents should aid in solving handling and control problems due to cargo shifting, and the usefulness of data on deaths/injuries per ton mile by mode of transport is questionable.

by Kenneth L. Pierson
Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20590
1976; 11p
Presented before the National Motor Vehicle Safety Advisory Council, Motor Vehicle Safety Seminar, Washington, D.C., 12 Jul 1976.
Availability: Reference copy only

HS-020 177

KEY ISSUES IN HEAVY TRUCK SAFETY

The Motor Vehicle Manufacturers Association of the U.S., Inc. (MVMA) has supported vehicle safety research since 1935 and today the program consists of seven categories: human tolerance, occupant dynamics, tires, lighting, driver vision, braking and handling, and collision data gathering and analysis--the latter two of which are the primary areas of concern. In addition to truck safety, the MVMA supports safety research for highways and the environment. Accident involvement of tractor-trailer combinations was reviewed and evaluated by two major independent research organizations at the request of the MVMA, and the findings of these studies are reported and grouped into the four categories of accident rates, accident characteristics, fatalities, and miscellaneous. MVMA suggests that future truck safety research efforts be directed toward developing better accident involvement reporting and evaluating procedures that segregate large from small truck data, developing and maintaining in-depth large truck accident studies, improving police reporting and collection techniques on large truck accident involvement, developing more effective motor truck inspection procedures, and developing comprehensive registration and licensing procedures for truck drivers. A discussion is presented which shows the importance of information exchange between the government, the public, the truck industry, and the scientific community before standards are formalized in proposed rulemaking, the need for the standard to be first established and then the possibility of design and production of a particular system determined, and the necessity of adequate field testing of safety standards before they are applied. The use of government (GSA) vehicles in a program of planned truck

research and testing of proposed requirements for which such field testing would be appropriate is outlined.

by Peter Griskivich
Motor Vehicle Manufacturers Assoc. of the U.S., Inc., Motor Truck Manufacturers Div., Washington, D.C.
1976; 19p
Presented before the National Motor Vehicle Safety Advisory Council, Motor Vehicle Safety Seminar, Washington, D.C., 12 Jul 1976.
Availability: Reference copy only

HS-020 178

COMMERCIAL VEHICLE SAFETY AS AFFECTED BY THE DEPARTMENT OF TRANSPORTATION'S DRIVER "HOURS OF SERVICE REGULATIONS"

The Department of Transportation's (DOT) driver "hours of service" regulations prohibit driving more than 10 hours in any tour of duty and any driving after an accumulation of 15 official "on-duty" hours during a tour of duty. Drivers must be given or must take eight hours off before becoming eligible to start another tour of duty, and there is a 60-hour limit on driving time in a 7-day week, 70 hours in an 8-day week. However, there is no particular day or time of day on which a week begins, and the method of computation is to count backwards seven or eight days and compute only the hours worked during that period. As a result, frequently even though a driver may have run out of hours on a weekly basis, by waiting a couple of hours so that the seventh or eighth day is a little further behind, the driver can accumulate hours and become eligible to go back out on the highway. Several examples are cited to point out the possibility of a driver going out on the highway when he/she has not had a proper eight hours of rest. Another problem with the current rules is that the number of hours in a workday are not accumulated consecutively. Carriers are permitted to "relieve" their drivers for indefinite periods during their 15-hour, maximum, on-duty shift for all meals, stops, breakdowns, delays, etc. In other words, companies can stop this 15-hour clock any number of times, for indefinite lengths of time, and then start it up again. A scenario is described which emphasizes the problems inherent in this system. The history of these regulations is traced since their inception in the 1930's at which time most drivers worked six, eight-hour days each week and the 70-official-on-duty hour workweek was the rarest exception while today it is the rule. It is not an exaggeration to say that 99% of the International Teamster's Union's officials do not know what are the current DOT hours of service rules. A lot more should be done by the DOT which can and should be held responsible for the egregious problem of fatigued commercial drivers and its perpetuation.

by Arthur L. Fox
PROD
1976; 10p 7refs
Presented before the National Motor Vehicle Safety Advisory Council, Motor Vehicle Safety Seminar, Washington, D.C., 12 Jul 1976.
Availability: Reference copy only

HS-020 179

FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1975

Tabulated data on fatal and nonfatal injuries in motor vehicle traffic accidents for calendar year 1975, by highway system, are compiled from reports submitted to the Federal Hwy. Administration by the 50 states and the District of Columbia as of Nov 1976. They include data for all roads and streets in the U.S. The first table presents a year-to-year comparison of fatality rates by highway system for the years from 1970 through 1975. Italicized indexes show percentages of the rates for 1970. The following 12 tables show fatal accident rates, fatality rates, injury accident rates and injury rates by highway system and state for 1975. The next table relates the 1975 fatality and injury accident data to vehicle registrations, population and number of licensed drivers. The remaining tables contain the detailed accident information on which the preceding tables are based. Since there is no single highway classification system in use in all the States for classifying accidents and travel data, the set of highway systems used in these tables is necessarily a compromise. The rates shown in these tables are uniformly carried out to two decimal places. This apparent precision surpasses the degree of accuracy of much of the data on which the computed rates are based. Because of the complexity of collection and classification of information about miles of highway, vehicle-miles of travel, and motor vehicle traffic accidents, and the necessity of subjective judgments at many points in the processes, the computed rates should be regarded as approximations. In addition to the fatalities reported, about 1,100 deaths per year occur in motor vehicle nontraffic accidents. The inclusion of nontraffic deaths in some of the figures published by the National Safety Council explains much of the difference between the statistics published by it and those published here.

Federal Hwy. Administration, Washington, D.C.
1976; 42p
Availability: GPO $1.50, Stock No. 050-001-00120-9

HS-020 180

WOULD DECLARING FEDERAL SMOG DAYS REDUCE AUTOMOBILE TRAVEL IN THE WASHINGTON, D.C. AREA? THE RESULTS OF A SURVEY OF TRAVEL BY EPA EMPLOYEES ON APRIL 19, 1976

A survey of employees of the West Tower of the Environmental Protection Agency (EPA) in Washington, D.C. who were released from work on Apr 19, 1976 at 9:30 AM because of a breakdown of the building's air conditioning was made to obtain data on their nonwork-related travel after dismissal. This information was used to estimate the trip and vehicle miles traveled (VMT) reductions that might occur on a day when Federal employees in the area were asked not to go to work because of intense smog conditions. The analog between the Apr 19 dismissal and a smog day is obviously not perfect. Employees did have to go to work on Apr 19, and nobody was advised to avoid driving due to atmospheric or other conditions. Nonetheless, the dismissal is more closely analogous to a smog day than are other nonwork days for which travel data are available. A self-administered, written questionnaire was

each trip they took prior to 6:00 PM on Apr 19. rate was 48%. The survey results suggest that deral smog day might reduce Federal employee ps by 18% to 42% and Federal employee VMT %. It is probably safest to interpret these results ative of travel reductions on an isolated smog first of a series of smog days.

/itz
l Protection Agency, Office of Policy Analysis,).C.
\/400-11/76-002; 1976; 17p
'orporate author

A NEED FOR COMPREHENSIVE ON

teristics peculiar to the bicycle as compared to e are not recognized, the current state of confu- e laws will continue to exist. Examples of vehicle e relative to the bicycle are given for Pennsyl- , California, New York, and New Jersey. They attempt to define and regulate bicycles in the it cars or other motor vehicles are regulated and e language to the effect that the provisions of ll not apply if, by their nature, they have no ap- bicycles. The question then remains about what cept the obvious, are not applicable. The Mas- hicle code can be called "quasidefinitive regula- an exception to inadequate legislation regarding ntaining a number of meaningful regulations. : scope of the Massachusetts approach is in- presents an attractive model for other states to guity in statutory regulation of the rights and du- ts is apparent in four issues that dominate case ion of the relevance of vehicle codes to bicycles, the standard of care in the use of bicycles, of where a bicyclist can ride and where traffic able, and an explanation of the applicability of cle) regulations to minors. Areas of specific con- model bicycle legislation should deal with, at a clude vehicular traffic laws, off-road riding, the st, registration and equipment regulation, and en-

N. Henszey
Quarterly v31 n1 p155-69 (Jan 1977)

See publication

RE OF THE BICYCLE AS A MODE OF RTATION IN THE UNITED STATES

totaled 3.7 million vehicles in 1960; in 1968 they to 7.5 million and remained at about that level . Sales then soared to 13.9 million in 1972 and ak of 15.3 million the following year. The total for l slightly to 14.1 million but then plunged to about n 1975. The reasons for this precipitous drop are economic recession and the unacceptance of the . practical means of transportation. Bicycle trip scussed in terms of their potential as a mode of n and in designing effective bikeway programs and include commuting to work, commuting to school, shopping, and recreation. It is highly doubtful that commuting trips to work by bicycle will ever constitute a significant portion of total commuting trips in the U.S. except in very specialized situations. Commuting trips to school appear to offer the greatest potential benefits to bikeway users, in terms of both economy and safety, especially in communities having large college student populations. Shopping trips offer little potential for expansion in most communities and should be considered as an incidental factor in bikeway planning. There is a large demand for recreational bicycle riding, both for exercise and for reaching recreational trip destinations. Safe and adequate bikeway facilities are essential to the further expansion of bicycle trips, particularly for the school commuter and recreational cyclist. State and Federal aid programs for bikeway programs are reviewed and tabulated data on expenditures for these programs by State are given. The future of the bicycle as a viable means of transportation will be determined by the availability of adequate bikeway facilities. More funding for these bikeways is essential to the future of bicycle transportation.

by Charles F. Floyd
Publ: Traffic Quarterly v31 n1 p139-53 (Jan 1977)
1977; 8refs
Availability: See publication

HS-020 183

CLOSED LOOP CONTROL OF SPARK ADVANCE USING A CYLINDER PRESSURE SENSOR

The objective of a new closed loop control technique for spark advance scheduling is to provide a schedule which is optimum in the presence of changing engine and environmental conditions. The benefits of adaptable spark control, the ability of a cylinder pressure based system to adapt to optimum spark in a single cylinder laboratory engine, and the transient performance of a controller mechanized in the laboratory are described. The technique has been shown to provide the necessary spark advance as a function of speed and load while simultaneously taking into account the changes in optimum spark advance caused by changes in atmospheric pressure, humidity and equivalence ratio. This scheme was simulated on a computer and averaged over the entire engine speed-load operating regime; it yielded average brake horsepower within 0.1% of optimum based solely on the cylinder pressure information. The system has demonstrated a transient settling time of 0.1 second.

by M. Hubbard; P. D. Dobson; J. D. Powell
Publ: Journal of Dynamic Systems, Measurement, and Control v98 ser G n4 p414-20 (Dec 1976)
1976; 6refs
Availability: See publication

HS-020 184

TRANSPORTATION SYSTEMS FOR AMERICA'S FUTURE. A MANAGEMENT OVERVIEW

Papers concerning an overall view of America's transportation needs for the future and how they can best be met are presented. Elliott M. Estes, President, General Motors Corp., discusses specifically the application of electronic systems for optimum engine control and for better mileage with mandated emission standards. A brief discussion of the future of the

various modes of transportation followed by a discussion of the future role of the railroads in freight transportation are presented by B. F. Biaggini, Chairman, Southern Pacific Transportation. The Target Car concept, an optimum design goal for an automobile which would best serve a broad middle segment of the motoring public's transportation needs, is discussed by Charles F. Bulotti, President, American Automobile Association. Charles M. Pigott, President, PACCAR, Inc., presents a discussion of the past, present, and future of the motor-carrier industry, with special emphasis on the Government's regulation in the truck manufacturing industry. Energy supplies in relation to transportation are briefly discussed. The belief that a continuation of the pattern of steady development of existing modes of transportation to meet changing public needs, rather than a switch to exotic modes is expressed by G. F. Richards, Chairman, The Budd Co. T. A. Vanderslice, Vice-President, General Electric Co., discusses the need, in the development of our future transportation system, of a national policy that recognizes each mode for the job it does best, that encourages the allocation of financial resources in keeping with that recognition, that stresses energy efficiency, and that maintains the role of private enterprise wherever possible.

Society of Automotive Engineers, Inc., 400 Commonwealth Dr., Warrendale, Pa. 15096
Rept. No. SAE-SP-420; 1976; 55p 3refs
Compilation of papers presented at the keynote session, Transportation Systems Overview, SAE National West Coast Meeting, San Francisco, 9-12 Aug 1976.
Availability: SAE $4.75

HS-020 185

NOISE BARRIER DESIGN HANDBOOK. FINAL REPORT

A handbook for use by the highway designer to aid in the design of noise abatement barriers provides a means of defining the geometric configuration of a barrier to produce a desired reduction (barrier diffraction and attenuation, barrier transmission, barrier reflections, multiple shielding effects, ground effects, barrier insertion). It also provides a design evaluation and selection procedure in which specific barriers (concrete barriers, concrete masonry unit walls, steel barriers, wood barriers, earth?berms, noise barriers f treatments for noise barriers, other materials) are detailed, and then evaluated in terms of cost, acoustical characteristics, and nonacoustical characteristics (e.g., durability, ease of maintenance, safety, aesthetics, community acceptance). The goal is preparation of a design which the designer believes will be accepted by the community and perform as desired both acoustically and nonacoustically, for reasonable cost.

by Myles A. Simpson
Bolt Beranek and Newman Inc., 1701 North Fort Myer Dr., Arlington, Va. 22209
Contract DOT-FH-11-8287
Rept. No. FHWA-RD-76-58; BBN-3199; 1976; 269p 16refs
Rept. for Feb 1976. Cover title: Highway Noise.
Availability: NTIS
1976; 449p
Availability: GPO $3.40, Stock No. 050-001-00117-9

HS-020 187

THE SECOND TIME AROUND. DDC. DEFENSIVE DRIVING COURSE

Reasons for graduates of the National Safety Council's (NSC) Defensive Driving Course (DDC) to take the course again after a lapse of several years (three years advocated by most professional safety supervisors) are presented. Repetition is the mother of learning, and driving techniques need to be learned and relearned and with each repetition comes a host of variations. The DDC, while highly standardized, is not the same from year to year, with the NSC policy being that the course is kept up-to-date in accordance with experience. Of the eight films, two are remade each year; and the "Student Workbook" is open for revision at each reprinting. Major revisions are made in the total course at intervals, and the NSC's Driver Improvement Program today is more than a training course; it is a program for producing a sustained level of accident-free driving. It is a program for driver performance management. It is emphasized that safe driving can be learned by organized instruction in the classroom; it does not have to be learned behind the wheel. The secret of crash avoidance skill is getting along with other units of traffic which is 90% a mental task. DDC teaches the driver the laws pertaining to traffic behavior and how to think about traffic situations in a more useful way. There are 400 minutes of class time in the DDC which is based on the epidemiological approach with the most important accident types given the most attention. The effectiveness of this program is demonstrated by the fact that 8000 graduates of DDC in 26 states had 32.8% fewer accidents after taking the course than they had in the prior year. The Defensive Driving League (DDL) addresses the "backslide factor." For a $5 fee, the DDC graduate receives a DDL membership card and pin and is provided with a bulletin each month which contains news and comment relevant to today's safe driver and a behind-the-wheel exercise to keep road skills sharp and a copy of the monthly "Safe Driver" magazine which contains information that reinforces defensive driving principles. The flagship of league membership, however, is the quarterly "Family Safety" magazine which introduces the member to the whole spectrum of consumer safety concerns. Finally, even with participation in the DDL, drivers need a periodic drill, which up-to-date DDC can give them.

by Chris Imhoff
Publ: Traffic Safety v77 n1 p8-10 (Jan 1977)
1977
Availability: See publication

HS-020 188

THE OFF-STREET ACCIDENT--AN OVERLOOKED STATISTIC

Motor vehicle nontraffic accidents receive little official attention although they occur often enough for human and economic losses to be substantial. The National Safety Council estimates that more than 1,000 people have been killed in nontraffic accidents each year since 1964. This toll exceeds bicyclist deaths on public roads during the same time and is about one third of the deaths caused by collisions with fixed objects. In 1967, the Texas Legislature required involved drivers to report to the Dept. of Public Safety, accidents caus-

ommercial parking lots where fees are charged, drive-in eaters; posted roads; loading docks; and race tracks. The po- ce in Texas are authorized to investigate nontraffic accidents nd file appropriate charges for code violations. Parking lots ere the location of more than half of the accidents reported Texas and summarized in the Dept. of Public Safety's sum- aries of nontraffic accidents from 1968 through 1975. During at period, 163 deaths and 10,905 injuries were reported as a esult of nontraffic accidents. Pedestrians suffered most, ac- ounting for 41% of the fatalities. Collisions with other motor ehicles produced the highest percentage of personal injuries 1%) followed by pedestrian injuries (21%) and by injuries in- urred as a result of fixed object collisions (19%). It is esti- ated that, because Texas law does not require reporting of ccidents in some places, as many as two thirds of the non- raffic accidents occurring in the state may not be reported. A ational projection of the probable total of accidents actually ccurring in Texas in 1975 indicates that as many as 1.5 mil- on nontraffic accidents could have occurred in the U.S. that ear. In the absence of similar data from other states, no accu- ate comparisons are possible and interest in the subject ap- ears to be quite low. Parking lot design could be useful in educing accidents. Some parking lot features that merit con- ideration from a safety standpoint are the adequacy of stall nd aisle widths; the use of designated walkways separating edestrian and vehicular traffic; the reduction of unprotected ixed objects; the control of speeds and vehicle movements hrough engineering design; and the use of standard signing. lso, the modernization of local zoning ordinances in respect o the safety of lot design could be productive in reducing ac- idents.

by James H. Lake
Publ: Traffic Safety v77 n1 p14-6 (Jan 1977)
1977
Availability: See publication

HS-020 189

VEHICLE HANDLING STUDY: INTERIM REPORT

Ninety-nine single vehicle and 41 two vehicle accidents occurring in part of Oakland County and Washtenaw County, Mich. from Sep 1, 1975 to Mar 31, 1976 were investigated. Data relevant to determination of the potential role of vehicle handling in accident causation were collected, together with injury causation information on 180 vehicles. Particular emphasis was placed on the collection of data pertaining to tires because of their clear and leading role in influencing handling characteristics. Tire pressure data were also obtained from Michigan State Police checklane inspections in the summer of 1975 on randomly selected vehicles. The checklane and accident population tire pressures were compared and additional comparisons were made between accident population subsets (single vehicle accidents; two vehicle, intersection type accidents; and two vehicle, nonintersection type accidents) on carcass type and tread depth data. The data reveal generally poor tire maintenance practices in both populations, but there is no evidence to implicate poor tires--improperly inflated, improperly matched, or insufficient tread--as causative factors in accident occurrence. This conclusion is highly tentative because there are only 180 vehicles in the file on which the analysis was performed, and because vehicle handling accidents are not well defined and accurately classified. It is recommended that the accident data base be expanded to include several hundred cases, with case selection criteria and sampling procedures remaining generally as currently defined. Vehicle handling accidents should be defined and concurrence obtained on the definition by government, industry, and private and university research organizations. Data collection should be expanded to include those pre-crash data elements about the driver, vehicle, and environment which are needed to determine whether or not an accident involves vehicle handling characteristics. Dynamic modeling approaches should be undertaken both for their inherent worth in furthering the understanding of the role that vehicle handling may have in accident causation, and to identify present weaknesses in the data elements or data collection procedures. Extensive statistical data are provided. Data elements collected on each vehicle and sampling procedures are shown fully in the Annotated Collision Performance and Injury Report which is appended.

by Lyle D. Filkins; Robert E. Scott; Charles P. Compton
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109
Contract MVMA-361122
Rept. No. UM-HSRI-76-18; 1976; 86p 16refs
Rept. for Sep 1975-Jun 1976.
Availability: Motor Vehicle Manufacturers Assoc., 320 New Center Bldg., Detroit, Mich. 48202

HS-020 190

MANAGEMENT ACTIONS NEEDED TO IMPROVE FEDERAL HIGHWAY SAFETY PROGRAMS. REPORT TO THE CONGRESS

The General Accounting Office (GAO) reviewed the states of California, Idaho, Louisiana, Maryland, Nevada, Pennsylvania, Texas, and Washington for compliance to the 1966 Highway Safety Act. None had established systematic procedures for selecting safety construction projects. Furthermore, the Federal Highway Administration (FHWA) had not developed adequate procedures to measure state progress in implementing their systems and did not know what progress had been made or when the states would meet the spirit of the act. Most state systems contained the following weaknesses. All accident data were not being analyzed to determine the most hazardous locations. Safety improvement projects were not always selected on the basis of cost effectiveness. Inventories of cost-effective projects were not being used to determine priorities. Projects financed with Federal-aid construction funds were not selected through a systematic approach. Federal-aid highways under local jurisdictions were not considered and did not receive safety funds. The Administrator of the FHWA should be required to determine, in cooperation with each state, the actions necessary to complete an adequate project selection system. Also, the States should be required to submit a plan including realistic time frames for implementing these actions. The FHWA Administrator should also monitor and evaluate states' development of project selection systems, and monitor states' implementation of project selection systems to insure that safety projects financed with regular construction and safety construction program funds are selected through a systematic approach. A definite and reasonable date should be established by which each State must select safety projects from inventories of cost-effective projects. The Highway Safety Act of 1976, which gives the states greater flexibility to transfer funds to high priority safety programs and which provides assistance in development of selection systems, should improve the overall effectiveness of the highway safety program. Appended material includes relevant statistical data, correspondence, comments by DOT,

and a list of officials responsible for administering the activities discussed.

Comptroller General of the United States
Rept. No. CED-76-156; 1976; 39p
Availability: GAO

HS-020 191

PROJECTED MOTOR VEHICLE REGISTRATION AND DRIVERS LICENSES OUTSTANDING 1976-2000. REV. ED.

A set of vehicle registration estimates for California to the year 2000 has been made by county for each of the four classes of vehicles--passenger vehicles, commercial vehicles, motorcycles, and trailers. Also included are estimates on the number of drivers license holders statewide (to year 2000), and various driver distributions by county, age of driver, and sex (to year 1978). It is assumed that developmental work in mass transportation systems will have a minimal impact on the projected number of registered vehicles or licensed drivers. Empirical data to substantiate the effects of the energy crises of 1973 and 1974 are not available, since other factors such as economic recession and an increasing rate of inflation clouded their impact. Vehicle registration projections were derived through a series of multiple regression analyses using population, gross national product (GNP), personal disposable income, and two "dummy variables"--energy conditions and wage-price controls, as independent variables. Dummy variables were used to represent atypical events. Data for the years 1964 through 1975 were used for the regression analyses. Drivers licenses outstanding figures have been projected to 2000 for the total state and estimates are given for 1976, 1977, and 1978 by county and sex. The licensing rates for both men and women have been increasing over the years. Particularly noticeable is the growth in the licensing rate of female drivers. The trend toward greater proportions of female drivers appears largely due to the increasing number of women assuming active roles in the labor force. Growth in the female driver population is expected to continue at a declining rate through 1985, at which time stabilization is anticipated. Data collected concerning driver population characteristics indicate that in 1976 about 53.5% of California drivers were males and 46.5% were females. The average age of male drivers was found to be 39.7 versus 39.4 for females. The average driving age for all drivers has decreased during the 12 years from 1964 to 1976, from a mean age of 39.9 to 39.5 years. More significant is the continuing trend toward a higher proportion of women drivers. The growth rate of senior drivers is steadily increasing at a greater rate than growth in the older citizen population generally. In general, the distribution of drivers by county is closely associated with population. Almost 32% of all California drivers reside in Los Angeles County and close to one half reside in the three southern counties of Los Angeles, Orange, and San Diego.

California Dept. of Motor Vehicles, P.O. Box 1828,
Sacramento, Calif. 95809
Rept. No. CDMV-R-48; 1976; 30p 4refs
Availability: Corporate author

HS-020 192

POLYURETHANE INTEGRAL FOAM MATERIAL, A CONTRIBUTION TO SAFETY IN AND ON MOTOR VEHICLES 0POLYURETHAN-INTEGRALSCHAUMSTOFF, EIN BEITRAG ZUR ERHOHUNG DER SICHERHEIT IM UND AM KRAFTFAHRZEUG0

Semiflexible polyurethane foams (PUR foams), having good shock absorption and reversible deformability, are excellent for various uses in motor vehicles, particularly in crumple zones which sustain minor but expensive damage. PURelastomers range between conventional rubbers and rigid plastics. They are characterized by combining high elasticity with a high amount of hardness, which is not possible with rubber. The area of the elastic modulus of 100 to 3000 kp/sq cm is practically covered only by polyurethane material. Due to their sandwich-structure - cellular core and solid skin - they have the high-grade properties of a solid elastomer and are also light in weight. Other characteristics include high tensile strength, braking elongation, tear resistance, abrasion resistance of the integral skin, resistance against oil, fuels, water, preservation and washing agents, and guaranteed resistance to weather conditions, hydrolysis, oxygen and ozone. Microcellular PURelastomers are, on the one hand, flexible up to -30° C, on the other hand they maintain their contours at temperatures up to 080° C. Integral foams do not contain any plasticizer, so that no staining or bonding problems arise. The material is very well suited for painting. Enamel bonding is perfect. The fire test according to the U.S. safety regulations (MVSS 302) is complied with. The liquid raw components of PUR foams are polyetherpolyol and polyisocyanate. Production of smaller parts is by either the two-stage (foam filler with a protective shell) or one-stage (integral foam material) process. PUR foams for large molded parts are usually manufactured by the reaction injection molding (RIM) process in which use of highly reactive systems produces short cycle times. The foams are well suited for series production because of their simple and low-cost manufacturing process. Vehicle components for which the materials have been used include buffers, protective strips, covers, body elements, fenders, and bumpers.

1977; 13p
Text also in the original German.
Availability: Reference copy only

HS-020 193

STUDY ON THE VIBRATION CHARACTERISTICS OF SPRING-FREE VEHICLES WITH PNEUMATIC TIRES 0UNTERSUCHUNG DES SCHWINGUNGSVERHALTENS VON UNGEFEDERTEN LUFTBEREIFTEN FAHRZEUGEN0

To make a tractor vibration classification for a European standard for the driver seat, numerous vehicles of various power ratings were tested on a standard track (smooth track). A tractor classification from the viewpoint of seat evaluation as a function of total tractor weight seemed to be justified, and the suggestion was made that the so-called standard tractors be placed in two weight categories. At first, various parameters on several tractors were modified in order to determine the effect of individual parameters on the vehicle vibration characteristics. A special experimental tractor with variable wheelbase was later prepared for the purpose of a systematic and complete analysis. The result of the measurement in the field indicated that a final and general conclusion as to whether and when the parameter modifications have a favorable or an adverse effect on tractor vibration characteristics could not be

reached. In addition, the measurements performed on several tractors subjected to the same parameter modifications showed different tendencies. Therefore, vibration properties resulting from the vehicle parameter modifications (variations) could not be simply transferred from one vehicle to another, because the transfer would cause a simultaneous alteration of more than one parameter. Because of these difficulties, the field tests were discontinued, and an attempt was made to express effects of the parameters mathematically - by means of a calculation model. In the process, a new calculation system was developed by which, based on the known data, any spring-free vehicle could be simulated on a table computer and its vibration behavior could be predicted. With the help of this calculation method the meaning of the amplitude and phase course alterations during the parameter variation can be clearly shown. Obtaining certain vehicle data is necessary: besides the generally known data, the tire elasticity and damping properties and the inertial moment of the transverse axis have to be determined. These data can be obtained at relatively small expense. Only when this calculation method was used could the effect of individual parameters on the tractor vibration characteristics be determined.

by Abdollah Owzar
1977; 14p 10refs
Text also in the original German.
Availability: Reference copy only

HS-020 194

ANALYSIS OF INJURY MECHANISMS IN ACCIDENTS INVOLVING CHILDREN ON FOOT, BASED ON INVESTIGATIVE STUDY AT THE ACCIDENT SITE 0ANALYSE DER VERLETZUNGSMECHANIK BEI KINDERFUSSGAENGERUNFAELLEN DURCH UNFALLFORSCHUNG AM UNFALLORT0

An analysis was made of 72 real pedestrian accidents from a traffic accident research program of the Technical University of Berlin and the Medical Highschool at Hannover. Fifty percent of the collision speeds of the vehicles were under 33 km/h for the pedestrian accidents. On the average, children were more severely injured than adults, by the same vehicle contour and collision speed. The type of vehicle contour (pontoon or wedge) is of great importance for the degree of injury in case of primary collision (vehicle/pedestrian): children are more severely injured by pontoon type front ends than are adults. The primary collision causes the serious injuries. In case of secondary collisions, a slight rise of the degree of injury occurs with rising collision speed. The most endangered areas are, for children: head, abdomen and thigh; for adults: head, thigh and thorax. In case of head injury, the most frequent severe injury of the pedestrian, the skull brain trauma of children shows a rate of 65%, which as a consequence leads to a high percentage of neurological-psychical defects. The bumper shouldn't only be positioned in view of vehicle to vehicle collisions, but it should be energy-absorbing with optimum height to the pedestrian. The vehicle front contour requires that parts of the outside vehicle superstructure adapt themselves to the biomechanical load values of a touching body under a given and defined deformation characteristic.

by Guenter Stuertz; E. G. Suren
1977; 8p 8refs
Text also in the original German.
Availability: Reference copy only

HS-020 195

1975 ACCIDENTS OF MOTOR CARRIERS OF PROPERTY

A report on accidents which occurred in 1975 is based on information submitted by motor carriers of property operating in interstate of foreign commerce, Bureau of Motor Carrier Safety (BMCS) regulations require a report to be filed when an accident involves a motor vehicle engaged in the interstate, foreign, or intrastate operations of a motor carrier subject to the Dept. of Transportation Act. An accident is defined as an event resulting in: the death of a human being bodily injury to a person who, as a result receives medical treatment away from the scene of the accident; or total damage to all property aggregating $2,000 or more. In 1975, there were 24,274 accidents reported to BMCS. These resulted in 2,232 fatalities, 26,374 injuries, and $158.2 million in property damage. Of those killed in reported accidents, 351 were truck drivers, 93 were other truck occupants, and 1,788 were pedestrians or occupants of other types of vehicle. Distribution of accident statistics by type of trip and type of accident shows that collision accidents which occurred on over-the-road trips accounted for 54% of the total number of accidents, 74% of the fatalities, 60% of the injuries, and 52% of the property damage. Noncollision accidents which occurred on over-the-road trips accounted for 23% of the accidents, 10% of the fatalities, 15% of the injuries, and 37% of the property damage. Some 19% of the accidents reported were collisions of vehicles engaged in local pickup and delivery operations, and these accounted for 14% of the fatalities, 22% of injuries, and 8% of property damage. Noncollision accidents which occurred on local pickup and delivery trips were lowest in all aspects, accounting for 3% of accidents, 1% of the fatalities, 2% of injuries, and 3% of property damage. Accident severity is expressed in the report in the following terms: fatality rate is the number of fatalities per 100 accidents; injury rate is the number of injuries per accident; and property damage rate is the amount of property damage per accident. A tabulated summary of 1975 data is provided, including total numbers of accidents, fatalities, injuries and property damage for the year. Additional data are divided into sections of tables, charts, and graphs detailing who was involved in accidents, the type of vehicle involved, where accidents occurred, what hour they occurred, what caused them, and what the results were.

Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20590
1976?; 84p
Availability: Corporate author

HS-020 196

HIGHWAY VEHICLE RETROFIT EVALUATION. PHASE 2 REPORT. TESTING AND FINAL EVALUATION RESULTS. FINAL REPORT

Engine dynamometer and vehicle chassis dynamometer tests were conducted with selected automotive retrofit devices, including the Ultrasonic Fuel System carburetor, high velocity intake manifolds, tuned exhaust systems, a multiple spark capacitive discharge ignition system, and the combination of intake manifold plus tuned exhaust system. The engine dynamometer tests were made for screening and characterization purposes. They consisted of steady state dynamometer tests of a 1973, 350 cubic inch displacement (CID) Chevrolet engine at road load cruise conditions of 25, 35, 45, 55, and 65

mph, and wide open throttle (WOT) conditions at 35 and 55 mph. The brake specific fuel consumption (BSFC) was measured at each condition. A baseline condition, with the engine in stock condition in all respects, was run before and after each retrofit device test. The goal of the chassis dynamometer tests was to evaluate the effectiveness of the devices under conditions which would be likely to exist if they were retrofitted to in-use vehicles. This meant that stock tune conditions of dwell angle, spark timing, and carburetor adjustment should be maintained. The significant results of all tests are summarized, and findings are grouped according to test type. The vehicle chassis dynamometer tests do not show any basis, with respect to full economy improvement, for recommending wide scale implementation of any of the retrofit devices tested. The small number of dynamometer tests run does not permit a statistical determination of the relative efficacy of this device. However, there do not appear to be any significant differences in fuel economy, particularly in view of normal test measurement accuracy limitations.

by M. G. Hinton; L. Forrest; W. B. Lee
Aerospace Corp., Environment and Energy Conservation Div., El Segundo, Calif. 90245
Contract DOT-F04701-74-C-0075
Rept. No. DOT-TSC-OST-76-19; 1976; 100p 2refs
Rept. for Nov 1975-Nov 1976.
Availability: NTIS

HS-020 197

REPORTS BIBLIOGRAPHY, SUPPLEMENT, JULY 1975-JUNE 1976

A bibliography of all reports published by the Transportation Systems Center from Jul 1975-Jun 1976 includes abstracts and accession numbers for each report, and contract numbers and report numbers when applicable. Reports are grouped by sponsoring agencies: Office of the Secretary of Transportation (OST); U.S. Coast Guard (USCG); Federal Aviation Administration (FAA); Federal Highway Administration (FHWA); Federal Railroad Administration (FRA); National Aeronautics and Space Administration (NASA); National Highway Traffic Safety Administration (NHTSA); and Urban Mass Transportation Administration (UMTA). Title, author, and corporate source indexes are provided. Reports listed with "AD" or "PB" numbers are available from the National Technical Information Service in either paper copy or microfiche. Prices can be obtained from the "Government Reports Announcements."

by T. F. Fitzgerald
Transportation Systems Center, Information Services Branch, 813 Kendall Square, Cambridge, Mass. 02142
Rept. No. DOT-TSC-OST-76-8; 1976; 188p
Availability: NTIS

HS-020 198

ON-BOARD DEFECT DETECTION AND WARNING DEVICES

The feasibility of using on-board defect detection and warning devices is determined to monitor safety-critical system variables of passenger cars, trucks, buses, and motorcycles. An on-board defect detection and monitoring system must be low in cost, probably under $100 owner cost per vehicle, if it is to be cost effective on the basis of accident involvement alone. However, decreased servicing costs could improve the cost effectiveness of a system. Some monitors currently available on motor vehicles as standard or optional equipment are those for brake lining thickness, windshield washer fluid level, brake fluid level, brake lining thickness, door closure/lock. One of the most elaborate systems currently available is offered by Toyota as standard equipment on some Corona models. Their system includes monitors for all of these variables (except door closure/lock) and monitors for several other variables not related to safety. The main obstacle to the introduction of on-board defect detection systems is the lack of suitable low cost sensors. The following variables can be monitored with at least moderate reliability using currently available sensors, although in some cases sensor costs are high. The following variables can be monitored with moderate reliability although in some cases sensor costs are high: tire pressure, brake, windshield washer and power steering fluid level, power brake booster vacuum, brake pressure ratio (front to rear), pedal travel and lining thickness, exterior lamp outage, and door, hood, trunk lock or latch. Tire pressure monitors have been developed and are available for use on trucks. Any of the sensors for the above variables could be used on trucks and buses where applicable. Some of the monitors (e.g., tire pressure, brake lining thickness, brake pedal travel, tail/brake light) could be used on motorcycles. No practical sensors have been developed to monitor the following variables although progress is being made on low cost carbon monoxide (CO) monitors, including the following: brake torque ratio, ball joint wear, shock absorbers, total steering system lash, exhaust gas emissions concentration (not a safety related variable), fuel leaks between tank and engine, and CO concentration in the passenger compartment. An on-board defect detection and monitoring system has been designed with costs estimated as follows: prototype system total, $5,563; prototype signal processing unit, $825; prototype display unit, $677 1/2; production system with central signal processing unit, $425.60; and production system without central signal processing unit, $322.40.

by F. E. Kellogg
Techwest Enterprises, Ltd., 3650 Wesbrook Crescent, Vancouver, B.C., Canada, V6T 1W5
Contract MOT-99699
Rept. No. MOT-S3261-60(TSRV); TP250; CR7601; 1976; 146p 222refs
Availability: Ministry of Transport, Rd. and Motor Vehicle Traffic Safety Branch, Ottawa, Ontario, Canada

HS-020 199

EXTERIOR VEHICLE NOISE AND ITS EFFECTS. A SURVEY OF RESEARCH ON EXTERIOR VEHICLE NOISE, TRAFFIC NOISE, AND THE EFFECTS OF NOISE ON PEOPLE

The three main subject areas of establishing a rationale for exterior vehicle noise standards are vehicle noise, traffic noise, and the effects of traffic noise on people. Major sources of vehicle noise are identified as tire noise, engine noise, engine intake noise, engine exhaust noise, and fan and cooling system noise. The principal standards for measuring vehicle noise levels are Society of Automotive Engineers (SAE) Recommended Practice J336, J366, and J986a (appended) and the International Organization for Standardization (ISO) Recommendation R362. Some of the temporal factors that affect traffic noise levels are: the time of day, the day of the week, and the season of the year. Measurement of traffic noise levels must be made for several times during these periods in order to achieve a mixed sample. Mathematical traffic noise models

ed by the sound energy that is diffracted around the top
ends of the barrier if the barrier is massive enough to
inate the direct sound. Recommendations have been
eloped by the Committee on Hearing of the American
demy of Ophthamology and Otolarynology and by the En-
nmental Protection Agency to set standards that specify a
imum allowable level of noise induced permanent
shold shift (NIPTS). Regulations developed in the U.S. by
Occupational Safety and Health Administration currently
w a maximum eight hour per day exposure of 90 dBA.
se affects sleep as well as hearing by delaying and by in-
apting sleep that is in progress. Because very few noise
veys have included thorough acoustical and sociological
surements, subjective responses to road traffic noise are
y understood in a general manner. Correlations between
ous measures of noise level and subjective response in-
te that annoyance tends to increase with increasing noise
el. There are many factors, called moderator variables,
ch influence the relation between noise exposure and sub-
ive responses. There is evidence of psychiatric morbidity
n exposures to noise, but there are contradictions and a
k of a sufficient quantity of results. A number of body
nges (decreased blood flow to extremities of the body,
rease in heart rate, increase in the diastolic blood pressure,
ation of the pupils, and increased gastro-intestinal mobility)
all related to the basic vasoconstriction of the peripheral
od vessels in response to sound. The detailed relationships
ween human responses and traffic noise is the general area
rently most deficient in research knowledge. It is con-
ered essential to obtain a better understanding of annoyance
to exterior vehicle noise, and the question of whether or
traffic noise can affect the general state of health is almost
mpletely unanswered. The question of noise caused impair-
nt of mental health is another subject which should be
roughly investigated.

J. S. Bradley
iversity of Western Ontario, Faculty of Engineering
ience, Canada
pt. No. MOT-TP1154; CR7602; 1975; 252p
ailability: Transport Canada, Rd. and Motor Vehicle Traffic
fety Branch, Ottawa, Ontario, Canada

S-020 200

HE IMPROVEMENT OF VEHICLE
SPECTABILITY

esign features could be introduced to simplify the motor
hicle inspection process now undertaken by most of the
ovinces of Canada to improve highway safety. Sixteen in-
ectability improvements were identified as feasible and cost
fective. These include: a fluid level check in the brake
stem; incorporation of a fluid sampling provision for the
ake system; checking for wheel cylinder leakage in the
akes; display of flexible brake hose data to be marked on
e vehicle; requiring the brake system to withstand a proof
ad in excess of the design pedal force; and measuring the
earing surface of brake drum and disc to detect the minimum
provision for measuring the stroke of the air-operated wheel actuators of brakes at each wheel of vehicles so fitted. Other improvements include internal inspection of drum brakes; embossing wheel rim codes on the hub or rim of the wheels so that the code can be read easily; improving the design of the load bearing ball joint in the steering and suspension system so that an objective indication of excess wear is given without hoisting the vehicle or taking measurements; display criteria for replacement of spherical bearings and ball joints in the steering and suspension system on a data plate permanently attached to the vehicle; and provide the original owner of a vehicle a concise maintenance schedule that can be used to record maintenance work performed on the vehicle. It proved impractical to develop definitive costs for each improvement. Order of magnitude costs were estimated as follows: six improvements less than $0.10 per vehicle; five improvements less than $1.00 per vehicle; and five improvements less than $5.00 per vehicle. Some vehicles alreay incorporate the proposed improvement and no additional costs would be incurred. Seven improvements involve software (provision of data, vehicle or component markings) and could readily be incorporated into Canada Motor Vehicle Safety Standards (CMVSS). Eight are based on devices or features that are currently available and could be implemented without technology constraints. One improvement would require development engineering.

by T. M. Wardle; J. Codrington
Acres Consulting Services, Ltd., Niagara Falls, Ontario, Canada
Contract MOT-99520
Rept. No. TP-249; CR-7604; 1976; 108p 88refs
Availability: Ministry of Transport, Rd. and Motor Vehicle Traffic Safety Branch, Ottawa, Ontario, Canada

HS-020 201

ARTICULATED VEHICLE STABILITY EVALUATION SERVICE: PILOT PROJECT

A study was made to assess the demand in Canada for a service to assist manufacturers, operators, and regulators in the evaluation of the stability of articulated vehicles to determine if the tractor-semitrailer and truck-trailer analytical models alreay existing could meet the needs of various potential users and to determine if further fundamental development of the existing models is necessary (and if so, determine the directions of development which would be of most benefit). Three requests for specific work to be performed were received . Highway Trailers of Canada Ltd. requested that the stability of a tractor-semitrailer combination having three fixed axles be compared with the stability of the same vehicle configuration equipped with the steerable semitrailer axle system as marketed by them. Economy Carriers Ltd. requested that an evaluation be made of the stability of a double semitrailer vehicle, preferably in comparison with a tractor-semitrailer-pup trailer combination of the same capacity. Finally, Province de Quebec, Ministere des Transports submitted a request covering several different problem areas, including the evaluation of the effects of various tire interchanges, axle spacings, hitch locations, transport of liquids, and mobile homes. Highway Trailers personnel expressed considerable satisfac-

tion with the results of the work since they quantitatively verified and supported their general experience with their steerable semitrailer axle system. Economy Carriers stated that the information submitted to them was of no particular use, since the vehicle studied was now operating successfully. Also, since the vehicle's operation was successful, further simulation studies were not needed. Personnel of the Ministere stated that the results submitted to them were of considerable interest, particularly in that they aided in the understanding of the manner in which axle spacings affect hitch forces. The costs incurred in replying to the requests consisted of labor and computing charges. There does exist a moderate level of demand for an articulated vehicle stability service. Much of the demand is latent rather than actual, owing to the unfamiliarity of many potential users with the basis and capabilities of the analytical techniques involved. A strongly interactive type of service is, therefore, indicated. It appeared to be more efficient to modify the basic models to accommodate the needs of each user than to attempt the construction of models of great generality. Appendices include a written description of the articulated vehicle stability evaluation service, a copy of the request from the Ministers des Transports, Quebec (in French), reports on results of work requested by the three users, and a description of the modifications and listings of the existing tractor-semitrailer simulation program made for the study.

by E. C. Mikulcik
Contract MOT-OST5-0095
Rept. No. MOT-TP-433; CR-7606; 1976; 98p 1ref
Availability: Transport Canada, Rd. and Motor Vehicle Traffic Safety Branch, Ministry of Transport, Ottawa, Ontario, Canada

HS-020 202

LOAD SIMULATION TESTING WITH ELECTRO-PNEUMATIC SERVO SYSTEMS

The introduction of closed loop electropneumatic systems for load simulation testing fills a significant gap between the limited capabilities of open loop pneumatic systems and the higher cost of closed loop hydraulic systems. Limitations of the open loop systems include time-consuming monitoring and adjustments to maintain load accuracy. Tests usually must be run at very low frequencies thereby often resulting in very long test durations. A basic pneumatic closed loop system includes an oscillator or other signal source, a servo controller, a pneumatic servovalve, and a pneumatic cylinder. The heart of the system is the pneumatic servovalve which provides precise electrical control of air flow to the cylinder. Higher accuracy is obtained with a minimum of adjustment. Variable load programs can be run, test conditions can be changed in much less time, and air consumption has been reduced by 50% in some tests. Furthermore, the same servo controller can be used for either pneumatic or hydraulic systems, thus providing flexibility in equipment utilization. Closed loop pneumatic systems are most suitable for component testing in the range of 100-2,000 lbs force and 0-10 HZ. Typical applications include steering systems, clutch controls, exhaust system components, steering column systems and brackets. Three typical test applications are described. The test involving the steering column system simulated rough road durability and has as its objective qualifying the steering column system for all car lines for an equivalent of 100,000 customer miles. Test parameters include two inputs to the steering wheel with vertical bending loads of 20-55 lbs and lateral bending loads of 15-35 lbs. A second test involves front suspension strut insulator fatigue and seeks to determine the fatigue life of the front suspension strut bushing (rubber) assembly for an equivalent of 100,000 miles. Test parameters consist of simulated up (jounce) and down (rebound) motions of suspension of 34° total and fore and aft loading of plus/minus 1200-lb range. The third test involves steering shaft universal joint and flexible coupling fatigue and is intended to evaluate the fatigue adequacy of the steering shaft universal joint and flexible coupling for an equivalent of 100,000 miles. It uses programmed torsional loads ranging from 150 to 660 pounds/inches.

by Ernie Sambrano; Richard E. Sipfle
Ford Motor Co.; Koehring Co., Pegasus Div.
Rept. No. SAE-760315; 1976; 6p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 203

OPTIMIZING--WHAT'S THAT?

Past and present concepts of mechanical test optimization are presented. Optimization failures are due to two main problems. First, the technique applied solves only part of the problem and may then introduce undesirable characteristics more detrimental than any possible performance improvement. Second, the technique is over-complicated or too sophisticated to allow efficient execution of the test, perhaps to the point of being impossible to complete. Two initial optimization attempts are "null pacing," including peak and dynamic, and classical amplitude control. Undesirable features are inherent in each. Peak null pacing problems include overshoot in which, with test rates too fast, there is no provision in the basic concept to prevent the feedback from overshooting the desired peak value, thus preventing acceleration of the test to the capabilities of the test system. A second problem is the feedback control system's inability to bring the feedback signal within the error band. For this problem failsafing is little more than a band-aid approach that times out the error and then either stops the test or allows the command to proceed. Dynamic null pacing will further decrease test rates, has the same problems as peak null pacing, and can have very high accelerations because of the start/stop nature of the waveform. The classical amplitude control concept has been applied in vibration test applications in hardware amplitude controllers with some success, but even with the addition of mean amplitude control it would be difficult to extend these devices to handle arbitrary waveforms without a substantial change in concept. Current optimization techniques frequently are combinations of those mentioned to meet individual test needs. Structural testing requires high accuracy and specimen safety, and a combination of hardware and software techniques will provide best optimization and failsafe, although speed will be sacrificed. Constant amplitude component testing requires high speed, but because safety is not critical, test duration should be minimized. Amplitude optimization will be best provided by sine block profiles typically derived from histograms or rainflows for component tests, and the avoidance of null pacing, which increases test duration. Hardware and software amplitude controllers have been implemented successfully in this testing area. Resonance testing requires high speed and energy conservation, and use of a resonance machine necessitates amplitude and frequency optimization. A hardware amplitude and frequency controller or a software amplitude controller can be utilized successfully in this area. Arbitrary component testing

quires high speed and accuracy of a variable amplitude. oftware and hardware optimizers provide the solution and ork with the characteristics of the hydraulic system to main- in control. FFT optimization testing requires optimizing to me arbitrary waveform when the relationships between gnal output and response are not even known. Fourier series chniques have been successfully used to solve this problem. ecialized parallel processors to perform FFT operations ed to be added to allow calculations to finish in reasonable ne, thereby defraying some of the cost. In data acquisition, rdware devices can be used to optimize software functions, d vice versa, as hardware is dumb but fast while software is iart but slow. Strictly defined functions requiring constant tention, such as continuously monitoring an error band on a rticular signal, are best performed by a hardware device. nctions requiring a great deal of flexibility, decision making numerical calculations are usually best solved with pro- ammable software.

Lance Finberg; Rod Larson
TS Systems Corp.
ept. No. SAE-760316; 1976; 11p
esented at Automotive Engineering Congress and
position, Detroit, 23-27 Feb 1976.
ailability: SAE

S-020 204

NEUBER'S RULE FATIGUE ANALYSIS ROCEDURE FOR USE WITH A MOBILE OMPUTER

mobile data acquisition and reduction system uses an iginal combination of minicomputer hardware in a field data duction system and a software program that predicts crack tiation fatigue life from a strain versus time history. The rdware is a minicomputer contained in a mobile trailer that n be moved to test sites and remains stationary during test- g and analysis. The software program modularizes the pro- ams according to specific tasks and provides real time ocessing to determine data stored on a disc for post- ocessing. It was decided to restrict output to only necessary formation, and a "conversational" mode of operation was signed to provide flexibility needed for individual users. The ain components used in the fatigue prediction procedure are follows. First, follow stress-strain response at the strain ge (nominal) according to material properties and the materi- 's memory logic as explained by the Rainflow counting ethod. Second, predict the stress-strain response at the notch ot according to material properties and Neuber's Rule. hird, calculate the notch root strain range and mean stress r each closed loop. Fourth, calculate the fatigue damage for ch closed loop by using strain-life material properties and aking a mean stress correction. Finally, calculate the time to ack initiation by summing the fatigue damage according to iner's Rule. The program performs the following tasks: read- g the peak-valley data file; storage of the temporary arrays nominal strain value, nominal stress, notch root stress, and otch root strain; computation of these same stress and strain alues; damage computation; life computation, histograms, d plotting the hysterisis loops. Simultaneous analysis of mul- le channels is provided, and iterative techniques can be per- rmed. When results of the procedure were compared with ta from the SAE Fatigue Design and Evaluation Commit- e's Cumulative Fatigue Damage Test Program, it was felt at despite some minor problems, the fatigue predictions are good and that this system will give the design engineer a time- ly look at projected durability of his machine.

by Stephen Downing; Dale Galliart; Tibor Berenyi
Deere and Co.
Rept. No. SAE-760317; 1976; 12p 8refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 205

COPPER-CHROMIUM-NICKEL ALLOYS FOR NOx REDUCTION AUTOMOTIVE EMISSION CONTROL CATALYSTS

Two copper-chromium-nickel alloys, IN-1013 and IN-1050, were found to have the ability to form a dual-functioning oxidation scale consisting of surface layers catalytically active for oxides of nitrogen (NOx) reduction on top of a protective chromia (Cr_2O_3) barrier layer. These scale formation characteristics result from a combination of the chemistry and microstructure of the alloys which are prepared as prealloyed powders. Prior to the oxidation activation treatment, the powders are consolidated by deposition onto a preform, typically expanded metal mesh, and fabricated into any of a variety of low mass, high surface, open structures. The two alloys were selected from among many screened in laboratory tests for activity, selectivity and response to cyclic thermal/oxidation reduction exposure. The laboratory tests were followed by limited engine dynamometer and vehicle evaluations. Results have shown net NOx conversion efficiencies to be above 80% at temperatures of about 1100° F or higher and for space velocities up to at least about 160,000 hr. -1. The useful air/fuel ratio (AFR) range or window for net NOx conversion increases with temperature, and above about 1100° F also increases with increasing nickel content and aging time. Near stoichiometric AFR values, three-way conversions of NOx, carbon monoxide (CO), and hydrocarbon (HC) are high, though HC conversion decreases with aging time. Both the IN-1013 and IN-1050 catalysts display a memory characteristic which could make them tolerant to rather wide cyclic variations in AFR during three-way type operation. Durability experience, though limited, has shown that IN-1013 will retain a high degree of net NOx conversion efficiency over extended mileage, but peak conversion will shift slightly to a richer AFR. Under rich conditions, selectivity and net NOx conversions may improve over those for fresh catalysts. Conversions of CO and HC decrease with age. Light gage catalyst weight loss during extended testing has been low. Short exposures to temperatures of about 2000° F may be tolerated, but extended exposure temperatures should be restricted to below about 1300° F for light gage catalysts and 1700° F for heavy gage catalysts. One type of application has been illustrated by the use of IN-1013 in vehicles equipped with the Questor-AP Parts Reverter emission control system. This system using IN-1013 as the NOx reduction catalyst, has achieved strict emission levels, lowered operating temperatures, and improved fuel economy. The system durability looks promising and tests are continuing.

by P. D. Goodell; R. H. Kane; W. W. Tuffnell
The International Nickel Co.
Rept. No. SAE-760318; 1976; 22p 20refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 206

LEAN THERMAL REACTOR PERFORMANCE CHARACTERISTICS -- A SCREENING STUDY

The automotive thermal reactor may be suitable for controlling the hydrocarbon (HC) and carbon monoxide (CO) emissions from lean-mixture engines. Little is known about the performance characteristics of "lean" reactors, however, since much of the previous research on reactors considered only rich-engine operation. The effects of six operating variables (engine speed, exhaust flow rate, port liners, insulation, engine air fuel, and spark timing) on lean-reactor performance were screened by means of a fractional factorial experiment. Also, spatial temperature and species concentration distributions within the experimental two-pass reactor were obtained at several operating conditions. Of the variables screened, reactor insulation had the largest effect on emissions performance. Higher engine speed, retarded spark timing, and a less lean air-fuel ratio were also shown to improve reactor performance significantly. Within the range studied, exhaust flow rate and engine exhaust-port liners did not significantly affect reactor performance. High HC conversion efficiencies were obtained at many combinations of the six variables. CO conversion efficiencies were generally lower, and at several conditions CO was produced within the reactor from the partial oxidation of HC. Internal sampling revealed that most of the HC oxidation occurred in the reactor core, which was both larger and hotter than the surrounding annulus.

by Ronald J. Herrin
General Motors Corp., Res. Labs.
Rept. No. SAE-760319; 1976; 15p 11refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 207

A GUARD SYSTEM TO LIMIT CATALYTIC CONVERTER TEMPERATURE

High-temperature sintering can cause loss of activity in the catalyst of an automotive emission control system. The elevated temperature required to sinter the catalyst could arise from a combination of a warmed-up converter plus unusually high engine-out carbon monoxide or unburned hydrocarbon "fuel." This unburned "fuel" could result from sustained engine misfiring due to faulty ignition or from a prolonged high-speed, closed-throttle coast. Such abnormal "fuel" input to the converter has been prevented in all 1975 General Motors production vehicles by using the more reliable High Energy Ignition system and by properly controlling engine operating parameters during a closed-throttle coast. During the Corporate-wide program to develop systems to limit catalytic converter temperature, a "guard" converter system was evaluated as one of many candidate solutions. The guard system uses a small monolith catalyst to oxidize a controlled fraction of the unburned "fuel" in the engine exhaust stream, then rejects heat from this partially treated exhaust before passing the gas on to the main bead-bed converter located downstream. In tests with a bead bed and a guard system installed on a 1974 pre-converter vehicle, maximum bead-bed temperature during closed-throttle coasts was lowered significantly, with no penalty in emissions on the 1975 Federal Test Procedure. However, the reliability of the guard system is limited by deterioration of the very small monoliths. This deterioration must be improved substantially before the guard system is a viable production candidate.

by James R. Mondt
General Motors Corp., Res. Labs.
Rept. No. SAE-760320; 1976; 8p 5refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 208

REJUVENATION OF LEAD-POISONED NOBLE METAL CATALYSTS

The effectiveness of acetic acid-ammonium acetate methods of catalyst rejuvenation by lead (Pb) removal was investigated in the laboratory as a function of temperature, duration of treatment, type of agitation, and cation. Catalyst samples poisoned by treatment with a lead acetate solution were used primarily, with confirmation by vehicle-aged catalyst samples. The results were generally encouraging. Washing of poisoned catalyst samples with 10% by weight acetic acid solution at room temperature for half an hour was sufficient to improve the hydrocarbon conversion of a catalyst poisoned with 5% by weight lead (typical of a catalyst aged for about 50,000 miles with fuel containing 0.03 grams of lead per gallon) by 15%. However, it was found that such a rejuvenated catalyst, if subjected to a laboratory repoisoning test with 0.03 grams of lead per gallon fuel, loses hydrocarbon activity rapidly. The rate of activity loss upon repoisoning appears to be about six times faster than the average loss rate experienced before the rejuvenation treatment. On the other hand, a poisoned catalyst sample which was rejuvenated by a more drastic treatment (two treatments for three hours each, at 195° F with ultrasonic agitation), appeared to have the same rate of activity loss upon further aging as a fresh catalyst after the initial aging. Testing also showed that there is no significant difference in rejuvenation effectiveness among acetic acid or ammonium acetate at the same concentration.

by Walter G. Rothschild
Ford Motor Co.
Rept. No. SAE-760321; 1976; 10p 5refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 209

THE 1975 INTERNATIONAL CONFERENCE ON PERSONAL RAPID TRANSIT

Through presentation and discussion of 47 papers and several panels, the conference did much to clarify the characteristics of personal rapid transit (PRT). Some of the conference highlights are as follows. The economic picture has improved considerably, as the cost per trip is nearly proportional to line spacing. In urban design, it was observed that PRT works best if the population density is between roughly 4,000 and 20,000 people per square mile, is relatively uniform, and if the land use is such that apartment buildings, stores, shops and office buildings are arranged as close as possible to the stations, with open space for various purposes farther from the stations. Most of the conferences was devoted to understanding the technology of PRT systems and their components. Results of one of the most useful reports concluded that two solutions

are most practical: the on-line station concept in which one always takes the next train or perhaps every other train, and second, a true personal rapid transit system in which the patron again takes any vehicle because that vehicle is programmed to take him directly to his destination station. Five foreign systems were presented, two group rapid transit (GRT) and three PRT. Although one has been disbanded, the others appear slated for urban demonstration by about 1980. The political perspectives session provided insight into politicians' points of view who strongly urged technologists to take into account the political aspects of deployment of new transit options. Only if engineers and planners involve themselves in the political process will a new transit concept like PRT come about. In particular, Indiana, Minnesota, and California politicians represented their states' plans for PRT systems. Finally, plans were made for promoting and encouraging the development and application of automated guideway transit (AGT) systems through a separate organization, to be called Advanced Transit Association (ATA). It will be international in scope and consist of people interested in the understanding and development of advanced transit systems.

by J. Edward Anderson
Raytheon Co.
Rept. No. SAE-760323; 1976; 10p 13refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 210

METALLURGICAL EXAMINATION OF SCORED AND RIDGED HYPOID GEARS

A metallurgical study has been made of the failure mechanisms of scored and ridged hypoid gears by eye in a surface examination, and by low power and electron microscoy is a subsurface examination to determine the mechanisms of adhesive and fatigue wear. The failure mechanisms in the scored regions of the hypoid gear set includes adhesion as an instrumental phenomenon of the wear process. Nevertheless, the mechanism of delamination appears more prominent in this particular case. White layers observed at the surface of the scored areas are believed to be composed of a structureless white martensite. This structure is developed by the action of catastrophic thermoplastic shear. The local heat generated due to the adiabatic slip and contact pressure is apparently sufficient to austenitize the surface layers, so it is in effect ausformed. Rapid quenching results in the white martensite observed. Ridging of hypoid gear sets is believed by many investigators to be preceded by some degree of rippling. The complexities of these phenomena are not completely understood. Rippling is generally accepted as being due to the mechanism of stick-slip motion which is due to the electrostatic component of the force of friction. Additives for EP lubricants diminish the dielectric breakdown strength of the base oil and reduce the electrostatic component of the force of friction. It is postulated that the waviness of a rippled gear surface may be the contacting asperities which create the parallel ridged markings through ploughing, adhesion, wear debris and abrasion. These were the mechanisms of wear found on the ridged Dana hypoid gear set. It would appear that the dark lines of the ridged pattern are composed of oxide and/or reaction products of the EP additives and base oil. This film exhibited light wear and as a bearing surface must display a very low coefficient of friction. The areas between the dark lines of the ridged pattern revealed moderate abrasive wear, adhesion, and surface fatigue in the form of pitting.

by E. W. Friess
Rockwell International
Rept. No. SAE-760325; 1976; 14p 2refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 211

DEVELOPMENT OF A REAR AXLE LUBRICANT

Research studies on a wide variety of industrial and laboratory organic chemical compounds have led to the development of a new high quality, sulfur-phosphorus rear axle lubricant. Through extensive use of bench-type screening tests, new technology was developed to provide a formulation with exceptional anti-rust performance as measured by the CRC L-33 Test. Other outstanding features include extreme pressure (EP) protection, long-term copper corrosion protection capabilities, foam control, and thermal oxidation stability. The additive components may be used in mineral oils or synthetic fluids where extreme weather operation is desired. The formulation may also be used with extremely shear-stable viscosity index improvers to formulate multigrade rear axle lubricants.

by W. F. Olszewski; D. D. Neiswender
Mobile R and D Corp.
Rept. No. SAE-760326; 1976; 12p 10refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 212

TEST TECHNIQUES FOR THE EVALUATION OF LUBRICANT EFFECTS ON AXLE BREAK-IN TEMPERATURE. INVESTIGATION WITH AN INTEGRALLY BUILT REAR AXLE OF A EUROPEAN SEDAN

Axle break-in temperature behavior was studied in a Volvo sedan equipped with an integrally built rear axle, driver at or below the maximum weight limitation imposed by the manufacturer. At constant dimensional pinion and carrier bearing preloads, axle lubricant temperature generated by this Volvo sedan was found to be dependent on ambient temperature and torsional axle preload. The dependency on torsional axle preload appears to be related to unit turning torque and not on the torsional preload of one of the components. The heat generated by the running-in of the pinion bearings, however, appears to contribute most heavily to the observed peak break-in temperature. Dependency of peak axle break-in temperature on lubricant is also suggested. At torsional axle preloads of 2 to 32 kg-cm, two sulfur-phosphorus gear lubricants exhibited a linear dependence of axle lubricant temperature to torsional axle preload. With two other lubricants, axle lubricant temperature appears to be proportional to torsional axle preload raised to a fractional power. At normalized torsional axle preload, two sulfur-phosphorus gear lubricants show significantly lower peak axle break-in temperatures. One of these gave a break-in temperature similar in magnitude to the low temperature observed with a lead-soap, active-sulfur gear lubricant. The test technique utilized for the evaluation of the break-in temperature properties of multipurpose gear lubri-

cants has been found to be highly repeatable and reproducible when peak break-in temperatures of gear lubricants are compared at similar torsional axle preloads.

by Z. M. Holubec; W. C. Brandow
The Lubrizol Corp.
Rept. No. SAE-760327; 1976; 15p 5refs
Prepared for presentation at the SAE Annual Meeting, Detroit, Feb. 1976.
Availability: SAE

HS-020 213

EFFECT OF REAR AXLE LUBRICANTS ON THE FATIGUE LIFE OF TAPERED ROLLER BEARINGS

The effect of rear axle lubricants on the fatigue life of tapered roller bearings was determined, employing a laboratory test fixture. The tests were conducted under a controlled thrust load, inner race speed, and jet oil inlet temperature. Six of the test lubricants were factory-fill axle lubricants for an automotive manufacturer; one was a premium rust and oxidation inhibited oil used as the baseline oil. Test conditions included thrust load, inner race mean Hertzian contact stress, inner race speed, inlet oil temperature, inlet oil flow rate, outer race fitup, and inner race fitup. The fatigue lives for the various rear axle lubricants are presented as percentages of the B-50 life of the baseline lubricant. The comparison showed that rear axle lubricants can reduce the fatigue life of tapered roller bearings 17-67% of rated life. In general, the lower viscosity lubricants had lower lives than higher viscosity lubricants. It was found that changes in the operating environment that may increase the rear axle lubricant temperatures, such as higher undercar temperatures and smaller rear axle cavities, can alter the favorable position that exists today in vehicles.

by Richard K. Kepple; Melvin F. Johnson
General Motors Corp., New Departure Hyatt Bearings Div.
Rept. No. SAE-760329; 1976; 8p 10refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 214

INSTANT SET POLYMER--A NEW DIMENSION IN PLASTICS

A new plastic and processing technology known as ISP (Instant Set Polymer) has been developed that allows production of essentially any size automotive part via liquid injection molding. Chemically, the polymer can be characterized as a polycarbamate which centers around urethane raw materials. Isocyanate plus a polyol, along with the proper catalyst will polymerize rapidly and exothermically. The heat of reaction for the system being considered is in excess of 20,000 cal. per lb. of polymer. To date, the new technology is highlighted by liquid reaction molding at near ambient temperatures; heavy section molding on short cycles; strong, rigid parts with isotropic properties; substantial energy savings during molding; and efficient, low cost equipment. A schematic diagram is provided of the special molding machine developed for liquid reaction molding of ISP. Physical strength properties of molded ISP parts are very well retained on outdoor exposure, even with no inhibitors or ultraviolet light absorbers. Liquid reaction molding promises to be one of the best answers for energy conservation in the plastic industry, since chemical energy is used. Also, the use of lighter presses and molds can result in energy and money savings. A number of ISP parts have been in use for over three years and are still in good condition. Some examples are power cable clamps, insulator pins, splash guards, covers for machinery, bases for pumps, and motor end bells.

by E. L. Kropscott; E. E. Jones; P. H. Cook
Dow Chemical Co.
Rept. No. SAE-760331; 1976; 7p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 215

A THERMOPLASTIC RIM 0REACTION INJECTION MOLDING0 SYSTEM FOR AUTOMOTIVE FASCIA

With reaction injection molding (RIM), thermosetting urethanes became available for use in making automotive fascia. The advantages of RIM over injection molding have become clear; parts larger than about ten pounds can be made on a production basis using thinner walls because of lower processing viscosities. In addition, equipment cost is lower, and energy consumption per pound of RIM material is lower when compared to TPU. A thermoplastic polyurethane has been developed which can be processed by RIM and which can be recycled as necessary by injection molding. An MDI-based quasi-prepolymer was developed specifically for this material. The use of MDI has several advantages over TDI; the reactivity is the same for both isocyanate groups in MDI, and the symmetry of the molecule permits more rapid and distinct domain formation, which leads to more uniform polymerization and harder materials employing minimal amounts of extender. A schematic diagram of the equipment used in the thermoplastic RIM system development work is provided. The material's properties meet specifications for automotive fascia, including painted bumperette impact and paint adhesion. The effect of postcure is to improve both high and low temperature properties. It is recommended that part weight reduction be achieved by using thinner wall thicknesses rather than by density reduction since density reduction weakens properties.

by P. S. Carleton; J. H. Ewen, Jr.; T. M. Shah; H. E. Reymore, Jr.; A. A. R. Sayigh
Upjohn Co.
Rept. No. SAE-760332; 1976; 11p 23refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 216

GLASS FIBER REINFORCED ELASTOMERS FOR AUTOMOTIVE APPLICATIONS--A COMPARISON OF RIM (REACTION INJECTION MOLDING) URETHANES AND ALTERNATIVE MATERIAL SYSTEMS

Glass fibers added to reaction injection molding (RIM) urethanes provide materials which offer the automotive engineer a broadened performance spectrum. The composite materials are stiffer and have a lower coefficient of thermal expansion than unreinforced urethanes. These attributes have been beneficial to the growth of the use of plastic materials

ver the past thirty years. High pressure RIM process equipment for the newer material systems can be designed to handle lass fibers. Each process equipment system must be analyzed n terms of the effect of glass fibers on the system's components. Performance comparisons with other automotive lastomers, such as injection molded thermoplastic urethanes nd EPDM compounds, show that glass fibers provide similar enefits to all of the competitive material systems. Glass fibers ot only increase the high temperature stiffness enough to neet guideline values for automotive fascia, but they also can nhance the low temperature impact properties. Comparative ata describe how tailoring of the elastomers is possible and esirable in order to meet current automotive fascia guidelines.

y Allan B. Isham
Owens-Corning Fiberglas Corp.
Rept. No. SAE-760333; 1976; 12p 7refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-020 217

RIGID RIM 0REACTION INJECTION MOLDING0--A MICROCELLULAR STRUCTURAL FOAM

RIM (reaction injection molding) technology has been used to levelop a breakthrough for flexible plastics in the automotive ndustry. The parts made by this process are thin sectioned ascia panels used as front or rear ends, replacing metal components. Because of the versatility of this chemistry and echnology, formulations have now been expanded to incorporate high rigidity. Rigid RIM or FASTFOAM is a thin, integral sandwich of tough, durable urethane skins around a low lensity urethane foam core. Section thickness for these naterials is 0.100 inch to 0.150 inch, although thicker sections an be used to provide additional rigidity and lower overall lensities. The materials have a degree of rigidity as measured by flexural elastic modulus in the range of 100,000 to 150,000 psi at densities between 50 and 65 pounds per cubic foot. Rigid RIM has the rigidity of high density polyethylene or the softer polypropylene grades, but is a crosslinked, thermoset material rather than a thermoplastic. The materials can be used to manufacture rigid structures which are stylish, have an easily painted finish, and feature low weight and nondamageability.

by Richard J. Ferrari
Davidson Rubber Co., Inc.
Rept. No. SAE-760334; 1976; 8p 9refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-801 950

THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. EXECUTIVE SUMMARY

A cost effectiveness analytical framework facilitates the process of highway safety administration and more effective allocation of resources. The approach is to examine the pattern of expected fatalities and injuries for the next 10 years in order to isolate major problem areas and to assemble and evaluate countermeasures that may be effective in dealing with them. Projections call for an increase of 56,000 traffic deaths in the year 1986, about the same rate as the present 3.4 fatalities per 100 million vehicle miles traveled. In addition, increases are projected for traffic accident injuries and property damage. Of 37 countermeasures used to forestall death and injury, mandatory safety belt usage, heightened enforcement of the nationwide 55-mph speed limit, and combined alcohol safety action countermeasures which have the potential to forestall tens of thousands of fatalities over the next 10 years. The costs for all countermeasures over and above current government expenditures is almost $42 million, greatly in excess of the levels the nation had previously chosen to spend on highways. The selection of countermeasure deployment in a systematic fashion for cost effectiveness and relative effectiveness can most advantageously be employed at the State level because the States are best able to assess and rank any countermeasure deployment in terms of applicability at a given site, the size of the population affected, physical highway conditions, special budgetary and/or political circumstances, and its integration with other complementary countermeasures in effect or being planned. The capacity of the States to execute such a procedure, however, has never been demonstrated. Recommendations are for both Federal and State governments to actively promote the universal use of safety belts and to continue to seek strong uniform enforcement of the national 55-mph speed limit. Pilot tests of the analytic approach carried out in this study should be conducted in several States. A more rigorous means should be developed using this study as a point of departure for stating goals, identifying needs, and measuring concomitant results within a changing traffic safety setting. Accelerated methods should be developed for solutions to special problems in U.S. territories in the Pacific. National safety performance should be reviewed in the framework indicated on a periodic basis.

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Excerpted from a rept. of the Secretary of Transportation to the U.S. Congress pursuant to Sect. 225 of the Highway Safety Act of 1973.
Availability: See publication

HS-802 037

DRIVER LICENSING: A BIBLIOGRAPHY

This bibliography cites literature acquired since the establishment of the National Highway Traffic Safety Administration in 1967. Citations follow the format used in the monthly abstract journal Highway Safety Literature and are indexed by a keyword-out-of-context (KWOC) listing, author, corporate author, contract number, and report number. Documents listed herein may be examined in the Technical Reference Branch, National Hwy. Traffic Safety Administration. Few of the documents are available for distribution by NHTSA. Availability is given in individual entries.

by Lois Flynn, comp.
National Hwy. Traffic Safety Administration, Technical Services Div., Washington, D.C. 20590
Rept. No. SB-08; 1976; 300p
Availability: NTIS

HS-802 047

SAFETY PROGRAM EVALUATION: A BIBLIOGRAPHY

This bibliography cites literature acquired since the establishment of the National Hwy. Traffic Safety Administration in

1967. Citations follow the format used in the monthly abstract journal Highway Safety Literature and are indexed by a keyword-out-of-context (KWOC) listing, author, corporate author, contract number, and report number. Documents listed herein may be examined in the Technical Reference Branch, National Hwy. Traffic Safety Administration. Few of the documents are available for distribution by NHTSA. Availability is given in individual entries.

by William E. Tarrants; Lois Flynn, comps.
National Hwy. Traffic Safety Administration, Technical Services Div., Washington, D.C. 20590
Rept. No. SB-09 ; 1976; 82p
Availability: NTIS

HS-802 052

EFFECT OF MARIHUANA AND ALCOHOL ON VISUAL SEARCH PERFORMANCE. FINAL REPORT

Two experiments were performed to determine the effects of alcohol and marihuana on visual scanning patterns in a simulated driving situation. In the first experiment 27 male heavy drinkers were divided into three groups of nine each, defined by three blood alcohol levels produced by alcohol treatment: 0.0%, 0.075%, and 0.15% BAC's. Significant changes in visual search behavior including increased dwell duration, decreased dwell frequency and increased pursuit duration and frequency were found under alcohol. In the second experiment 10 male social users of marihuana were tested under both 0 mcg and 200 mcg tetrahydrocannabinol per kilogram bodyweight. Marihuana was found to have no effect on visual search behavior. Changes are recommended in the driving situation to reduce the accident liability of those individuals still driving under the influence of alcohol. First, limited capacity to interpret roadway communications must be taken into account. California has improved highway signing by increasing the number of signs and the sign conspicuity, and very effective results have been accomplished. Secondly, the selectivity of drug and alcohol effects on driving must be noted; whatever effects alcohol has on information processing, they are reflected in the output of the oculomotor system, whereas marihuana effects are apparently not so reflected. Third, training in visual search strategies to compensate for drug effects should be provided in driver training. Finally, improvements in testing are recommended. A steering control task should be used in the film instead of the more alerting urban setting, which may counter the effects of the alcohol. Visual search testing should be replicated with moderate drinkers for understanding of the total drinking population. Further study of the "gaze fixation" phenomenon should be undertaken. The effects of fatigue should be studied in relation to visual search. Finally, on-the-road studies should be conducted to validate conclusions of the simulation findings.

by H. A. Moskowitz; K. Ziedman; S. Sharma
University of California, Dept. of Computer Science, School of Engineering and Applied Science, Los Angeles
Contract DOT-HS-150-3-668
Rept. No. UCLA-ENG-7615; 1976; 161p 60refs
Rept. for Jun 1973-Dec 1975.
Availability: NTIS

HS-802 059

HYBRID COMPUTER VEHICLE HANDLING PROGRAM. FINAL REPORT

A Hybrid Computer Vehicle Handling Program (HVHP) has been designed to demonstrate realistic dynamic simulations of passenger vehicles and trucks for the following suspensions: four-wheel independent, independent front and solid rear axle, solid front and rear axles, and any front suspensions with dual tires on a solid rear axle. Model validation was accomplished using parametric data representative of a 1974 Chevrolet NOVA, 1974 VW Campmobile, 1974 White Tractor and various other automobiles and trucks. Braking, steering and combinations of braking and steering were input to the simulated mathematical model for validation, and the simulation time histories were then compared to full scale test data. This hybrid vehicle handling program can be used for general studies of vehicle dynamics. The following programs performed utilizing HVHP indicate its range of performance: passenger car tire effects, vehicle handling test procedures (VHTP's) for recreational vehicles, truck and bus tire effects, passenger cars pulling trailers, straight line braking, braking in a turn, turning on a rough road, trapezoidal steer, sinusoidal steer, and drastic steer and brake. Performance of the NHTSA standard passenger car VHTP's and calculation of the associated performance comparison variables are simulation options. A special interface maximizes user control and information retrieval from the hybrid computer, and allows program use by vehicle engineers as well as computer specialists. Simulation runs are easily performed and inexpensive.

by P. F. Bohn; R. J. Keenan; J. Prowznik
Johns Hopkins Univ., Applied Physics Lab., Johns Hopkins Rd., Laurel, Md. 20810
Contract DOT-HS-213-3-695
Rept. No. BCE-T-0610/TSA 006; 1976; 455p 19refs
Rept. for Jul 1974-Jul 1976.
Availability: NTIS

HS-802 060

EVALUATION OF GEOMETRIC AGGRESSIVENESS OF FULL-SIZE AUTOMOBILES. FINAL REPORT

The results of an experimental research program involving five full scale crash tests and two full scale static crush tests conducted to investigate the geometric aggressiveness of larger automobiles in collisions with smaller vehicles. Effort was directed primarily toward generating the experimental data required to meet the overall program objective of evaluation of geometric aggressiveness effects. Crash tests included two front-to-front and three front-to-side impacts of a 1975 Honda CVCC and a 1975 Plymouth Fury. Crush testing included a frontal barrier crush of the Honda CVCC and a combined front-to-side crush of the Plymouth front into the Honda side at a 60° angle. The results of all testing, both static and dynamic are presented. The data presented include plots of all vehicle and simulated occupant accelerations including first and second integrations of each, still photographs of vehicle exteriors and interiors pre- and post-test, tabular and graphical presentations of vehicle deformations, tabular summaries of occupant injury criteria, and a vehicle crashworthiness determination based on occupant survival distance. Detailed information is included on the static crush test methodology employed. A novel feature of this car-to-car crush test is the application of many load measuring devices to determine the various load paths in the respective vehicles in a single crush

test. A brief discussion of a computer simulation model for a frontal barrier crash is also presented. Results of a simulated barrier crash are compared to an actual barrier crash test. All data generated in these tests are presented except high speed motion pictures of the crash tests.

by Melvin O. Ryder, Jr.
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221
Contract DOT-HS-5-01099
Rept. No. ZP-5776-V-1; 1976; 546p 1ref
Rept. for Aug 1975-Sep 1976.
Availability: NTIS

HS-802 066

DEVELOPMENT OF A MOTOR VEHICLE MATERIALS HISTORICIAL, HIGH-VOLUME INDUSTRIAL PROCESSING RATES COST DATA BANK (COMPACT TYPE CAR). FINAL REPORT

A detailed cost analysis of a compact class automobile was conducted to supply information for a Cost Data Bank. The specimen selected was a two-door 1975 Pinto equipped with the following: 2300cc 2V4-cylinder engine, select-shift Cruise-O-Matic, power steering, passenger compartment carpeting, power front disc brakes, front bumper guards, air conditioning - Selectaire, accent group, tinted glass, wide color-keyed vinyl insert bodyside moldings. Two methods were used. A micro-analysis method generated various costs (variable, fixed, manufacturing, tooling, other cost plus profit, dealer markup and consumer costs) using an industry type estimating technique to achieve the cost per item per vehicle and the cost per pound of vehicle for each item. The vehicle was dismantled and its various components and subassemblies were analyzed in detail to determine the weight and estimated manufacturing cost associated with each item. From this basic data, other categorical costs were estimated, both in total for each item and on a cost per pound basis. The various items were grouped into several levels of assemblies on a basis of practiced industry groupings to arrive at total cost categories for a complete vehicle. The second method is the macroanalysis in which various average costs were determined for a study of five years of historical financial records of an automotive corporation, in this study, the Ford Motor Co. This method was divided into three phases: the isolation of Ford Motor Co. variable, semifixed and fixed cost; the determination of the average price, weighted by sales of Ford Motor Co. automobiles sold in the U.S.; and a simple empirically developed model that will simulate Ford Motor Co. operating results with significant changes in volumes, mix, prices, and "fixed" expenses. The purpose was to assure that the microanalysis of the individual product line costs were consistent with the actual overall experience of Ford Motor Co.

by Malcolm R. Harvey; Daniel J. Chupinsky
Pioneer Engineering and Mfg. Co., 2500 E. Nine Mile Rd., Warren, Mich. 48091
Contract DOT-HS-5-01153
1976; 281p
Rept. for May 1975-Mar 1976.
Availability: NTIS

HS-802 071

STATIC BRAKE INSPECTION INVESTIGATION. VOL. 2. FINAL TECHNICAL REPORT

A set of inspection criteria and techniques was generated for the conduct of static (nonperformance) brake inspections for passenger vehicles and light trucks without removing wheels. The Static Brake Inspection System was based on a survey of the state-of-the-art of existing systems, criteria and techniques, as well as a thorough literature search. The following items were considered for inspection: lining and pad thickness, hub seal leakage, drum and disc wheel cylinder leaks, and drum internal diameter. Other items include drum and disc cracks, disc thickness, lining in correct location, and drum brake adjustment mechanism. Further inspection items were drum and disc guide, clips, springs, and cotter pins; master cylinder fluid level; master cylinder external leak; brake line/connector leaks, corrosion, and abrasion; brake fluid moisture contamination; and brake fluid sludge. The basic performance objectives of a static brake inspection system were determined based on trade-off studies of inspection items and available inspection methods. Also, a fifty-four vehicle test measured inspection items, including master cylinder external leak; brake fluid sludge; drum and disc guides, clips, springs; and lining in correct location. It was concluded that access ports, visual indicators, and a proof test provided the best approach to static brake inspection without removing wheels. A preliminary static brake specification was written. Because of the need to make use of common vehicle modifications, a dialogue with auto manufacturers was established and the inspection system was carefully reexamined from the point of view of cost, producibility and lead time required for incorporation into production vehicles. The dialogue made it clear that an inboard approach to access ports in backing plates and splash shields was more practical than access ports in wheels and drums. It avoided highly stressed parts, wheel-to-drum alignment problems, and offered a potential for reduced inspection times. The inboard approach was recommended for inclusion in the final specification. Inspection tools recommended include a light source and a mirror, a brake pedal effort gauge for the proof test, and a lining to drum clearance gauge. A final specification for a Static Brake Inspection System is stated as follows. Passenger cars and light trucks under 10,000 lbs gross vehicle weight shall have access ports and visual indicators suitable for inspecting disc and drum wheel brake condition without removing the vehicle's wheels. The visual indicators and access port shall be so configured that inspection can easily be accomplished with a referee light source and mirror. Passenger cars and light trucks furthermore shall be capable of withstanding a proof test load of 200 lbs applied to the brake pedal for 10 seconds and reacted through the driver's seat. The proof test load is intended to condition a vehicle's brake system for subsequent static and dynamic brake inspection. This inspectability requirement is applicable to vehicles-in-use only and is not a minimum design standard for new vehicles.

Avco Systems Div., 201 Lowell St., Wilmington, Mass. 01887
Contract DOT-HS-4-00949
1976; 348p 63refs
Rept. for Jul 1974-Jun 1976.
Availability: NTIS

HS-802 073

PERFORMANCE EVALUATION OF THE NHTSA ADVANCED "S" SERIES 50TH PERCENTILE ANTHROPOMORPHIC DUMMY. VOL. 1. FINAL TECHNICAL REPORT

The physical characteristics and performance of the NHTSA "S" series anthropomorphic dummy were measured and evaluated, including both dummy component parameters and whole dummy responses in replicate sled tests. Four typical vehicle restraint configurations were used: Type two belt, pre-inflated air bag, simulated instrument panel - Type one belt, and energy-absorbing steering column. Component measurements are presented in terms of the requirements of the "Purchase Description of the NHTSA 50th Percentile Anthropomorphic Test Dummy" and the applicable parts of the 49 CFR Part 572 - Anthropomorphic Test Dummy. Comparisons of component performance relative to Part 572 requirements formerly tested for the Highway Safety Research Institute (HSRI) and GM50X reflect the reproducibility of results obtained from component tests of each pair of dummies. Sled test results were analyzed with respect to the repeatability of a given dummy on a run-to-run basis and to the reproducibility of results between dummies of the same manufacturer. Further comparisons are made between the "S" dummy and a Part 572 "control" dummy tested in identical environments. A secondary objective was to assess the performance and utility of a thin film piezoelectric surface pressure gage based on analysis of recorded signals from several of these instruments attached to the dummy in some of the sled tests. Sensors were installed under belt restraints in Type two belt configuration tests, on dummy head and chest surfaces in air bag configuration tests, and under lap belts and on the dummy head in simulated instrument panel configuration tests. It is concluded that the majority of the "S" dummy dimensional and joint range-of-motion measurements conform to the prescribed requirements of the NHTSA Purchase Description. However, several segment weights lie outside Part 572 specified tolerances. Furthermore, the mass distribution of the "S" dummy is such that notable differences in lower torso and upper leg moments of inertia exist between the "S" and the Hybrid two (Part 572) designs. From the results of component tests of the "S" dummies, it is concluded that both heads do not conform to acceleration response requirements of Part 572 and that not all head-neck responses in pendulum tests lie within prescribed limits. It is also observed that the thorax stiffness of both "S" dummies is much lower than the equivalent represented by Part 572 requirements, and that the lumbar spine equivalent and abdomen stiffnesses of both "S" dummies greatly exceed the levels implicit in Part 572 specifications. Finally, the femur load responses of the knees of both dummies are observed as being within Part 572 tolerances. It is generally concluded that, based on Part 572 component performance requirements, the "S" dummy is not equivalent to the Part 572 dummy. Using results of sled tests of two "S" dummies and one Part 572 Dummy, two HRSI and two GM50X dummies, it was found that two dummies do not provide an adequate sampling of the dummy population to permit generalization of comparative performances.

by Daniel E. Massing; Phyllis E. Yates
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221
Contract DOT-HS-5-01260
Rept. No. ZS-5778-V-1; 1976; 294p 11refs
Rept. for Jun 1975-Jul 12-14, 1976.
Availability: NTIS

HS-802 074

PERFORMANCE EVALUATION OF THE NHTSA ADVANCED "S" SERIES 50TH PERCENTILE ANTHROPOMORPHIC DUMMY. VOL. 2. ACCELERATOR SLED TEST DATA. FINAL REPORT

Four sled test configurations were employed to evaluate the dynamic performance repeatability of the NHTSA "S" Series dummy. Type-2 belt, pre-inflated air bag, energy-absorbing steering column, and Type-1 belt with simulated instrument panel test enviornments were utilized to measure the performance of two identically fabricated "S" dummies. In addition, test of a Part 572 dummy with Type-2 belts were performed to establish a control data set for this configuration. The graphical results of a statistical analysis performed on the results obtained from replicate tests of each configuration are presented.

by Daniel E. Massing; Phyllis E. Yates
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221
Contract DOT-HS-5-01260
Rept. No. ZS-5778-V-2; 1976; 518p
Rept. for Jun 1975-Jul 12-14, 1976.
Availability: NTIS

HS-802 077

THE DEVELOPMENT AND EVALUATION OF A MOTORCYCLE SKILL TEST, MANUAL, AND KNOWLEDGE TEST. FINAL REPORT

As a step in reducing the high accident rate that characterizes initial motorcycle operation, a skill test, written manual, and knowledge test were developed and evaluated. The basic source of information used in preparing the manual and tests was an inventory of critical knowledges and skills as obtained through a comprehensive analysis of motorcycle operator tasks. The skill test is an off-street measure designed to assess the following operating skills: starting on a hill, making a sharp turn, turning while accelerating and decelerating, controlled stopping, judging turning speed, avoiding obstacles, and emergency stopping while in a straight line and in a curve. Administration of the skill test yielded inter-examiner reliability coefficients of .9, while a correlation of .8 was obtained between test scores and judgments of proficiency made by experienced motorcycle operators. The manual provides critical information involved in safe motorcycle operation, including the following topics: preparing to ride, vehicle control, preparations for visibility, observing, maintaining distance separation, handling dangerous surfaces, night riding, emergencies, carrying passengers and cargo, group riding, getting in shape to ride, and maintaining the motorcycle. It is written entirely at the fifth-sixth grade reading level. The knowledge test consists of 75 items drawn entirely from the manual. Reliability coefficients range from .5 for 25-item tests to an estimated .8 for the entire 75 items. Evaluation of the project yielded several conclusions. It was decided that the manual is capable of effectively communicating information that is critical to safe motorcycle operation, and that the skill test is capable of assessing an operator's proficiency relative to critical vehicle control skills. It was also decided that additional tests are required to measure an applicant's ability to recall and apply knowledge of safe operating procedures in actual operation. This need is capable of being met through an on-street test, however, it is

felt that a simulation device may provide a cost-effective alternative.

by Kenard McPherson; A. James McKnight
National Public Services Res. Inst., 421 King St., Alexandria, Va. 22314
Contract DOT-HS-5-01143/DOT-HS-5-01165
1976; 119p 11refs
Rept. for May 1975-Jul 12-14, 1976.
Availability: NTIS

HS-802 079

THE DEVELOPMENT AND TESTING OF PARENT INVOLVEMENT IN DRIVER EDUCATION. FINAL REPORT

A driver education program (PAIRED Program) which integrated professional in-class instruction with parent-supervised on-road driving practice was developed in this project. Instructional materials (Parent Handbook, Implementation Guide for Instructors, and Instructional Cards) were developed to supply the necessary tools of instruction. The program was introduced in a pilot test in three schools--an affluent suburban school, a middle-class urban school, and an inner-city urban school. The program was planned in two levels--model program (MP) (full parent participation including meetings with driver education instructors) and materials-only (MO) program. Due to the limited response on the part of parents in the urban schools, the MP was implemented only in the suburban school. The MO program was implemented in the suburban school and the urban schools. The primary difficulty was gaining the initial cooperation and participation of the parents. The response of the suburban school parents who did participate was enthusiastic and positive. In both MP and MO programs, instructors and parents regarded the instructional materials as very useful and easy to understand.

by Joel M. Reuser; Robin S. McBride; Theodore Rosen; Myron Rimm
Human Resources Res. Organization (HumRRO), 300 N. Washington St., Alexandria, Va. 22314
Contract DOT-HS-4-00993
Rept. No. TR-75-22; 1976; 252p 15refs
Rept. for Jun 1975-Sep 1975.
Availability: NTIS

HS-802 081

VEHICLE EYE REFERENCING DATA. FINAL REPORT

Eye position data were collected for 25 driver subjects as they viewed ten targets in a laboratory buck, a static vehicle, and an on-the-road vehicle. The vehicle used in the testing was a 1976 Vega stationwagon which represented the compact car class, one of the several package geometries the Motor Vehicle Manufacturer's Assoc. is using to generate eye position data. The purpose of the data collection was to enable further comparisons of eye position data as a function of vehicle package geometry. In this case, it was suspected that the closeness of the compact car's structure to the driver's body may restrict movement and thus result in smaller eyellipses. Test results showed that subjects positioned their seats further back in the actual vehicle than in the laboratory buck. For all targets in the X dimension, subjects' eyes were closer to the front of the vehicle in the buck than in the static or moving vehicle. For the Y and Z dimensions, only targets requiring large body movements (extreme left, right, and turn around) had means that were different for the buck and actual vehicle tests. Variance of subjects' eye locations in the X dimension was greatest in the on-the-road tests. For the Y and Z dimensions, however, subjects' eye position variance was greatest in the static vehicle tests. It was concluded that the static buck tests resulted in different eye locations in the X dimension, and less variance in eye locations in the X, Y, and Z dimensions. In terms of mean eye location, there were no differences between the static and on-the-road vehicle tests. However, the on-the-road tests resulted in larger variances for the X dimension and slightly smaller variances for the Y and Z dimensions. Appendices include the subject consent form, information and anthropometric data sheets, a listing of eye locations for individual subjects by target and environmental condition, summary table for multivariate analyses, and plan view plots of targets by environmental conditions.

by R. R. Mourant; R. G. Arbogast
Wayne State Univ., Dept. of Industrial Engineering, 640 Putnam, Detroit, Mich. 48202
Contract DOT-HS-6-01301
1976; 95p 1ref
Rept. for Dec 1975-Sep 1976.
Availability: NTIS

HS-802 082

CITIZENS BAND MONITOR GUIDE

A guide is presented which was designed to encourage, facilitate, and increase the participation of volunteer citizen's band (CB) radio groups in highway safety by providing standard monitoring guidelines. The principal objective of the guide is to enhance the entry of any victim of a medical or other emergency into the Emergency Services System through the cooperation of the CB radio operator. The purpose of monitoring is to form a link between those on the highways and those who can help them by listening for, and passing on vital information regarding emergency calls on channel nine of the Citizen's Band. This link is made up of monitors (each of whom services an assigned area) who team up with other area monitors providing 24 hour coverage through each day. The monitor passes vital information on to police, highway patrol, fire stations, Coast Guard, emergency medical services, or other stations where help can be obtained. The monitor must guide help to the accident scene, act as a relay station between separate stations or mobile units, and keep records of calls and responses. The four "C's"- Be Calm, Be Courteous, Be Correct, and Be Concise--are the basis for effective monitoring, and each behavior is briefly discussed. Other procedural topics which are discussed include: the proper rate of speaking, message formulation, standard message structure, pronunciation of numbers, emergency terminology, methods of relaying messages, coping with a high level of traffic, and handling conflicting information. Names of people and names of locations should be transmitted carefully using the International Phonetic Alphabet for unusual or difficult spellings or when radio transmission is poor. A guide to the correct pronunciation of numbers is provided, as is the International Phonetic Alphabet, and a list of do's and don'ts when speaking on the emergency channel. The primary responsibilities involved in eliciting information from callers are listed. The seven questions to be asked of a caller are outlined, in their proper sequence, along with techniques to be employed to calm the caller. The discussion of operating techniques includes a description and a listing of the Associated Public Safety Communications Officers (APCO) aural brevity code, ten telephone

techniques to apply during an emergency call, and a word about Federal Communications Commission (FCC) regulations regarding profanity. General and specific instructions for completing the National Emergency Action Radio (NEAR) monitor log are given and sample pages are shown. Log codes are described and personnel severity definitions for fatal injury, incapacitating injury, nonincapacitating evident injury, and possible injury are provided. Property severity definitions for disabling damage, functional damage, other motor vehicle damage, and other property damage are also given. A detailed chart provides information by type of incident for information which should be asked of caller, the name of the authority which should be contacted, and any special instructions which are pertinent to the emergency.

National Hwy. Traffic Safety Administration, Emergency Medical Services Branch, Washington, D.C. 20590
1976; 39p
Availability: GPO $.80, Stock No. 050-003-00235-6

HS-802 083

AN AUDIBLE AUTOMOBILE BACK-UP PEDESTRIAN WARNING DEVICE--DEVELOPMENT AND EVALUATION. FINAL REPORT

An audible back-up warning device for use on automobiles was developed and field-tested. Examination of existing back-up accident data revealed that an estimated 73% of these accidents would have been prevented if the pedestrian could have heard a warning signal; and that older (45 years and older) segments of the population comprise the primary "population at risk" and, would be therefore, the main benefactors of a warning signal system. Research led to a design ambient noise level requirement to be exceeded less than 5% of the time between 63 dBA and 87 dBA, based on expected ambient noise variations and typical spectra at various accident sites. The warning signal (a tone at 1250 Hz pulsed on for 0.1 sec and off for 0.2 sec) is generated by a small loudspeaker mounted at the rear of the vehicle. An essential element of the design, that the system sense the ambient level and adjust its output accordingly, results in a warning signal level approximately equal to the A-weighted noise level throughout the danger zone. This is comparable to a level at least 10 dB above the pedestrian's detection threshold. Evaluation of a prototype system was conducted in typical parking sites using pedestrian subjects of opportunity. Results comparing the normal situation with a test sequence using the warning signal indicated a tenfold improvement in the number of pedestrians warned of the presence of a backing vehicle.

by Ron Brown; Louis C. Sutherland
Wyle Labs., Wyle Res., 128 Maryland St., El Segundo, Calif. 90245
Contract DOT-HS-5-01185
Rept. No. WR-76-12 ; 1976; 206p 41refs
Availability: NTIS

HS-802 086

TIRE PARAMETER DETERMINATION. VOL. 1. FINAL REPORT. SUMMARY

by Dietrich J. Schuring
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00923
Rept. No. CC-ZM-5563-T-1; 1976; 26p
Rept. for 1 Jul 1974-31 Dec 1975. For abstracts, see HS-802 087 (Vol. 2, Pt. 1), HS-802 088 (Vol. 3, Pt. 2), HS-802 089 (Vol. 4, Pt. 2), HS-802 090 (Vol. 5, Pt. 2), HS-802 091 (Vol. 6, Pt. 2), HS-802 092 (Vol. 7, Pt. 2), HS-802 093 (Vol. 8, Pt. 2), and HS-802 094 (Vol. 9, Pt. 2).
Availability: NTIS

HS-802 087

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 2 - TECHNICAL REPORT: PT. 1. TEST METHODOLOGY

Major force and moment characteristics of passenger car and light truck tires currently distributed in the U.S. are presented in empirical form suitable for use in the National Highway Traffic Safety Administration (NHTSA) vehicle dynamics mathematical model. The data realistically represent on-the-road performance of tires of all sizes and types covered by FMVSS 109 and 119 with the exception of large truck tires. Tire construction and performance parameters of primary importance in testing were normal force, longitudinal force, lateral force, aligning torque, slip angle, longitudinal slip, inflations pressure, road skid number under wet conditions, and road speed, also under wet conditions. Secondary and tertiary parameters include inclination angle, overturning moment, road speed under dry conditions, water thickness, rolling resistance moment, loaded radius, road skid number under dry conditions, and temperature. About 400 tires were chosen to represent the population and proof was made of good correlation between the tire data measured on Calspan's Tire Research Facility (TIRF) and corresponding data measured on a passenger car for braking and cornering. The data are presented for steady-state road and TIRF tests, nonsteady-state road and TIRF tests, and the results of transient maneuvers simulated on TIRF. Eight model coefficients, under continuous revision, describe tire force and moment characteristics in the form of a few mathematical equations. Equations and illustrative examples are provided for lateral force, longitudinal (braking) force, and moment. The TIRF basic program was designed to generate the tire coefficients and model constants needed for vehicle handling simulation, and to secure information on the effects of design and construction parameters on tire performance. It included variation of normal force, slip angle, inclination angle, and longitudinal slip. Nine parameters (eight performance parameters plus state of wear) were investigated. Four basic tire tests are described: cambering tests of free-rolling tire at various loads and camber angles, at zero slip angle and constant pressure; cornering/cambering tests of free-rolling tire at various slip and inclination angles, at rated load and constant pressure; cornering tests of free-rolling tire at various loads and slip angles, at zero inclination angle and constant pressure; and braking tests

easurements were performed in accordance with Society of utomotive Engineers (SAE) Recommended Practice J332a. ach tire was subjected to a cornering and braking run on a ry surface at 30 mph and 24 psi. A statistical analysis could e made of the distribution of important performance parameers in terms of construction type, and within each type, of spect ratio, load rating, tire size, and carcass materials, to rovide direct inputs in many safety related studies, such as in e design and analysis of nonlocking braking systems, and in onsidering the effect of tire mixes on a vehicle. Extensive atistical data are appended, including the estimated distribuon of tire sizes (passenger and light truck) for 1976, a tailed listing of tires tested, and TIRF/VERF data evaluation bles.

y D. J. Schuring
alspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
ontract DOT-HS-4-00923
ept. No. ZM-5563-T-2; 1976; 301p 34refs
ept. for Jul 1974-31 Dec 1975. Other documents in the series re HS-802 088--HS-802 094.
vailability: NTIS

IS-802 088

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 3 - TECHNICAL REPORT, PT. 2 (1 of). TIRE TEST DATA

or tire numbers 8 to 74, a data package is presented for each hich contains the following information: a list of tire identifiation data such as size, brand name, cord material, shore ardness; a list of run identification data such as run number, oad speed, and design load; a tire footprint taken at T&RA oad and 24 psi; tire uniformity data; lists of cornering and raking coefficients (both computer model constants and the efficients measured for each load); a plot of lateral force ersus slip angle at 50%, 75%, 100%, 125%, 150%, and 175% T&RA loads; a plot of lateral force versus slip angle at design oad and four inclination angles of zero, two, four, and six egrees; and a plot of braking force coefficient versus slip atio at 75%, 100%, 125%, and 150% T&RA loads. When the ame tire was tested more than once under different condiions, a data package was prepared for each test set.

y D. J. Schuring
alspan Corp., 4455 Genessee St., Buffalo, N.Y. 14221
ontract DOT-HS-4-00923
ept. No. ZM-5563-T-1; 1976; 486p
ept. for 1 Jul 1974-31 Dec 1975. Other documents in the eries are HS-802 087, HS-802 089--HS-802 094.
vailability: NTIS

IS-802 089

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 4 - TECHNICAL REPORT, PT. 2 (2 of). TIRE TEST DATA

For tire numbers 75 to 144, a data package is presented for ach which contains the following information: a list of tire dentification data such as size, brand name, cord material, hore hardness; a list of run identification data such as run umber, road speed, and design load; a tire footprint taken at T&RA load and 24 psi; tire uniformity data; lists of cornering nd braking coefficients (both computer model constants and he coefficients measured for each load); a plot of lateral force versus slip angle at 50%, 75%, 100%, 125%, 150%, and 175% T&RA loads; a plot of lateral force versus slip angle at design load and four inclination angles of zero, two, four, and six degrees; and a plot of braking force coefficient versus slip ratio at 75%, 100%, 125%, and 150% T&RA loads. When the same tire was tested more than once under different conditions, a data package was prepared for each test set.

by D. J. Schuring
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00923
Rept. No. ZM-5563-T-1; 1976; 487p
Rept. for 1 Jul 1974-31 Dec 1975. Other documents in the series are HS-802 087--HS-802 088, HS-802 090--HS-802 094.
Availability: NTIS

HS-802 090

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 5 - TECHNICAL REPORT, PT. 2 (3 of 7). TIRE TEST DATA

For tire numbers 145 to 230, a data package is presented for each which contains the following information: a list of tire identification data such as size, brand name, cord material, shore hardness; a list of run identification data such as run number, road speed, and design load: a tire footprint taken at T&RA load and 24 psi; tire uniformity data: lists of cornering and braking coefficients (both computer model constants and the coefficients measured for each load): a plot of lateral force versus slip angle at 50%, 75%, 100%, 125%, 150%, and 175% T&RA loads; a plot of lateral force versus slip angle at design load and four inclination angles of zero, two, four, and six degrees; and a plot of braking force coefficient versus slip ratio at 75%, 100%, 125%, and 150% T&RA loads. When the same tire was tested more than once under different conditions, a data package was prepared for each test set.

by D. J. Schuring
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00923
Rept. No. ZM-5563-T-1; 1976; 584p
Rept. for 1 Jul 1974-31 Dec 1975. Other documents in the series are HS-802 087--HS-802 089, HS-802 091--HS-802 094.
Availability: NTIS

HS-802 091

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 6 - TECHNICAL REPORT, PT. 2 (4 of 7). TIRE TEST DATA

For tire numbers 231 to 307, a data package is presented for each which contains the following information: a list of tire identification data such as size, brand name, cord material, shore hardness; a list of run identification data such as run number, road speed, and design load: a tire footprint taken at T&RA load and 24 psi: tire uniformity data: lists of cornering and braking coefficients (both computer model constants and the coefficients measured for each load): a plot of lateral force versus slip angle at 50%, 75%, 100%, 125%, 150%, and 175% T&RA loads; a plot of lateral force versus slip angle at design load and four inclination angles of zero, two, four, and six degrees: and a plot of braking force coefficient versus slip ratio at 75%, 100%, 125%, and 150% T&RA loads. When the

same tire was tested more than once under different conditions, a data package was prepared for each test set.

by D. J. Schuring
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00923
Rept. No. ZM-5563-T-1; 1976; 485p
Rept. for 1 Jul 1974-31 Dec 1975. Other documents in the series are HS-802 087--HS-802 090, HS-802 092--HS-802 094.
Availability: NTIS

HS-802 092

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 7 - TECHNICAL REPORT, PT. 2 (5 of 7). TIRE TEST DATA

For tire numbers 308 to 376, a data package is presented for each which contains the following information: a list of tire identification data such as size, brand name, cord material, shore hardness; a list of run identification data such as run number, road speed, and design load; a tire footprint taken at T&RA load and 24 psi; tire uniformity data; lists of cornering and braking coefficients (both computer model constants and the coefficients measured for each load); a plot of lateral force versus slip angle at 50%, 75%, 100%, 125%, 150%, and 175% T&RA loads; a plot of lateral force versus slip angle at design load and four inclination angles of zero, two, four, and six degrees; and a plot of braking force coefficient versus slip ratio at 75%, 100%, 125%, and 150% T&RA loads. When the same tire was tested more than once under different conditions, a data package was prepared for each test set.

by D. J. Schuring
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00923
Rept. No. ZM-5563-T-1; 1976; 466p
Rept. for 1 Jul 1974-31 Dec 1975. Other documents in the series are HS-802 087--HS-802 091 and HS-802 093--HS-802 094.
Availability: NTIS

HS-802 093

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 8 - TECHNICAL REPORT, PT. 2. TIRE TEST DATA

For tire numbers 377 to 430, a data package is presented that contains the following information: a list of tire identification data such as size, brand name, cord material, shore hardness; a list of run identification data such as run number, road speed, and design load; a tire footprint taken at Tire and Rim Assoc. (T&RA) load and 24 psi; tire uniformity data measured on the tire uniformity grading (TUG) machine; lists of cornering and braking coefficients (both computer model constants and the coefficients measured for each load); a plot of lateral force versus slip angle at 50%, 75%, 100%, 125%, and 175% T&RA loads; a plot of lateral force versus slip angle at design load and four inclination angles of zero, two, four, and six degrees; and a plot of braking force coefficient versus slip ratio at 75%, 100%, 125%, and 150% T&RA loads. When the

same tire was tested more than once under different conditions, a data package was prepared for each test set.

by D. J. Schuring
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00923
Rept. No. ZM-5563-T-1; 1976; 439p
Rept. for 1 Jul 1974-31 Dec 1975. Other documents in the series are HS-802 088--HS-802 092 and HS-802 094.
Availability: NTIS

HS-802 094

TIRE PARAMETER DETERMINATION. FINAL REPORT. VOL. 9 - TECHNICAL REPORT, PT. 2. TIRE TEST DATA

For tire numbers 431 to 622, a data package is presented that contains the following information: a list of tire identification data such as size, brand name, cord material, shore hardness; a list of run identification data such as run number, road speed, and design load; a tire footprint taken at Tire and Rim Assoc. (T&RA) load and 24 psi; tire uniformity data measured on the tire uniformity grading (TUG) machine; lists of cornering and braking coefficients (both computer model constants and the coefficients measured for each load); a plot of lateral force versus slip angle at 50%, 75%, 100%, 125%, and 175% T&RA loads; a plot of lateral force versus slip angle at design load and four inclination angles of zero, two, four, and six degrees; and a plot of braking force coefficient versus slip ratio at 75%, 100%, 125%, and 150% T&RA loads. When the same tire was tested more than once under different conditions, a data package was prepared for each test set.

by D. J. Schuring
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-4-00923
Rept. No. ZM-5563-T-1; 1976; 439p
Rept. for 1 Jul 1974-31 Dec 1975. Other documents in the series are HS-802 088--HS-802 093.
Availability: NTIS

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